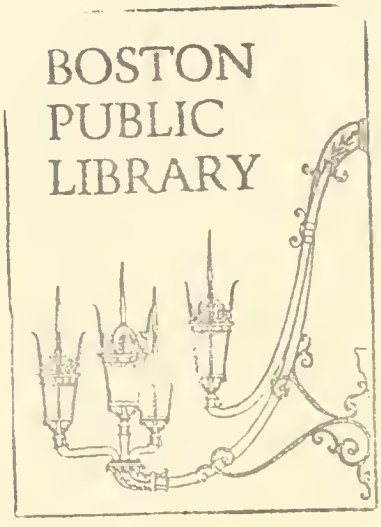
GOVDOC
BICA
1283
+
Tech.
APP.


BOSTON
PUBLIC
LIBRARY

CENTRAL ARTERY/I-93 CORRIDOR

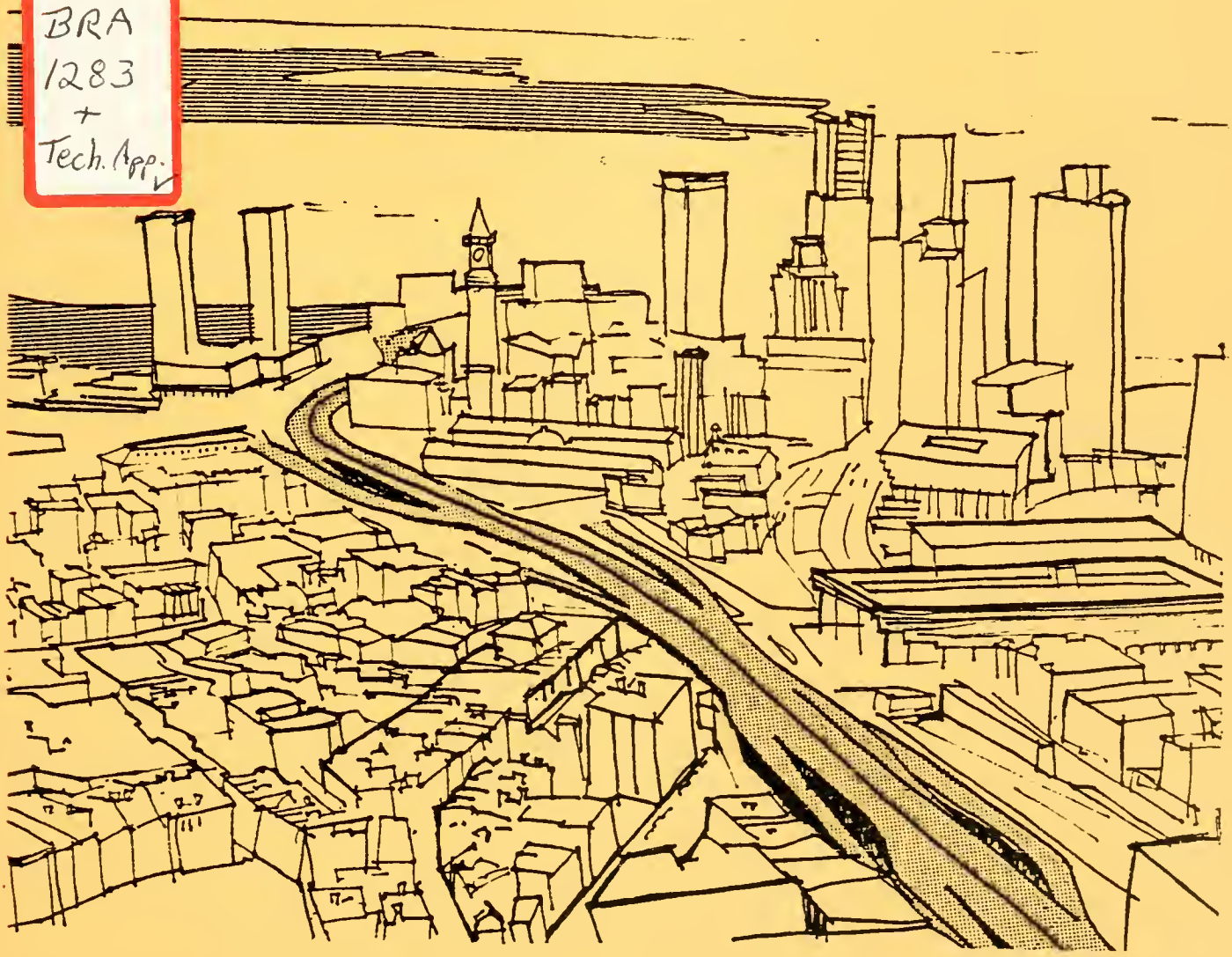
"BOSTON PUBLIC LIBRARY"

DOC
RA
93

DIRECTOR'S OFFICE
FILE COPY
DO NOT REMOVE

CENTRAL AREA PLANNING STUDY

GOVDOC
BRA
1283
+
Tech. App.



BOSTON, MASS. AUGUST 1978

The Commonwealth of Massachusetts
Executive Office of Transportation and Construction
Department of Public Works
Office of the Commissioner
100 Nashua Street, Boston 02114

August 16, 1978

DIRECTOR'S OFFICE
FILE COPY
DO NOT REMOVE

Mr. Norman Van Ness
Division Administrator
Federal Highway Administration
100 Summer Street Suite 1517
Boston, Massachusetts 02118

Dear Mr. Van Ness:

The attached documents constitute Corridor Planning Studies of the proposed improvements to the Central Artery in the Central and South Areas of the Corridor. The study was undertaken by the Commonwealth to determine feasible corridors and alternatives. Based on the technical work, and following a series of meetings with agencies, individuals and community groups, I find that the projects are feasible and should proceed into environmental impact analysis, for reasons cited in the document.

The focus on the Central Artery has emerged from a decade of examination of local and national transportation policies. This examination has yielded the following:

1. We have moved from a search for new alignments for additional urban expressways to detailed study of how to improve service levels in all modes of transportation.

2. Analysis of the existing highway network has revealed several serious bottlenecks in the system serving Eastern Massachusetts. These must be corrected.

3. Chief among these is Boston's Central Artery, a 2.5 mile stretch of highway that carries more traffic and experiences more accidents than any other comparable stretch in the state. In addition to serving as the sole north-south expressway within Route 128, the Artery connects with Storrow Drive, the harbor tunnels, the Mystic Bridge and the Mass. Turnpike and serves most of the traffic to Downtown, the seaport and Logan Airport.

Because the Central Artery is the predominant road facility in the region, alterations made to it will affect the regional economy of the Boston Metropolitan Area, which is expected to grow by 3.5% per year. For example, if the Central Artery is not reconstructed, and the growth of the regional economy were retarded by as little as 0.1%, the region would permanently lose $1,080,000,000 over the 40-year life of the facility. Obviously, it is difficult to pinpoint this type of figure. The environmental and engineering analysis to be undertaken will attempt to define in closer measure these economic impacts. The lack of improvements to the Artery would potentially mean no growth, with severe negative economic, social and environmental consequences for the region.

Plans to improve the Central Artery have been moved forward in an effort to ensure that this vital link in Eastern Massachusetts' highway network can fulfill its critical transportation function, thereby enabling the region - and particularly metropolitan Boston - to realize the full economic growth potential. This work has been underway for seven years, during which feasibility analyses have demonstrated the problems and potential of the facility. It has been part of a process reflecting local, regional and state growth and development policies, which are mirrored in new federal urban policies as well. I have reviewed these policies below to demonstrate the integral role which Artery improvements have in the continuing development process in Boston and in Massachusetts.

Relation to State Policies

Massachusetts has been a leader in developing state growth and development policies in concert with local communities. These have been defined both by present and past gubernatorial administrations, and also by the joint efforts of the state legislature, municipalities, and regional planning and development organizations. The policies which have resulted are nationally known for their emphasis on the revitalization of older urban centers, with a redirecting of state and federal assistance to this end. The state has acknowledged its responsibility to assist this process through targeting state investments to focus on older developed communities, through the infusion of new jobs in these areas, and through growth management and economic development investments which are within control of the state. A great many documents record this process and fully illustrate the emergence of these policies. On the state level, a Development Cabinet, consisting of the Lieutenant Governor, the Secretaries of Manpower Affairs, Communities and Development, Transportation and Construction, Environmental Affairs and Consumer Affairs, and the State Planning Director, who serves as Chairperson, has formulated an economic development program for Massachusetts.

In this program, Artery improvements have been identified as a critical work program element for the state. The Office of State Planning, in conjunction with the state legislature and virtually all of the cities and towns of Massachusetts, has been instrumental in integrating local, regional and state growth policies. These give further emphasis to the important roles of our older urban centers and the need for the state to strengthen and revitalize these places through strategic public investments, along with encouragement of private investments based on the existing and improved public infrastructure. Other state development policies have been profoundly influenced in these directions, and include the state energy conservation program, industrial development strategy, coastal zone management program, and a battery of policies concerned with enhancing the economic strength and environmental quality of the state's developed areas.

Relation to Regional and Local Policies

Within the Boston metropolitan area, regional and local policies have emerged to reinforce the state policies. For transportation, the broad state policies serve as a guide for specific plans and programs which are part of the continuing planning process. Artery improvements were first suggested by the City of Boston some years ago, and the state has been supportive in advancing the concept of improvements within the context of local and regional goals. The state funded preliminary feasibility analyses undertaken by the City. Subsequent regional plans have reflected this joint interest and the proposal for improvement of the Artery has been included in all federally required transportation certification documents produced over the past several years, and has met with approval of the six-agency Metropolitan Planning Organization. Furthermore, the proposed improvement has been integrated with regional plans for open space improvements, water quality management, economic growth and with the current focus on transit and roadway improvements in and around the Core of the region.

Boston's Downtown is important to the present and future of the region - it contains 300,000 of the City's 500,000 jobs and represents 23% of the metropolitan area's 1.3 million jobs and 13% of the state's 2.4 million jobs; it provides $5 billion of the $7.5 billion of earned income for the City, $20 billion for the metropolitan area, and $36 billion for the state.

Programs of the City of Boston are closely integrated on both policy and organizational levels with potential Artery improvement. The City has a long-standing strategy of using public policies and

investments to leverage private investment in the Downtown area. Urban renewal programs which began the process of Downtown revitalization are now being completed. Five major renewal projects have been undertaken Downtown, and all are immediately adjacent to the Artery Corridor. New projects which are being developed will fill gaps along the Corridor and strengthen residential and commercial uses. Other new developments are taking place in areas adjacent to Downtown where the Artery serves for principal access. They are located in part on federally-decommissioned lands and are designed in significant part to replace lost jobs. When implemented they will supplement the existing annual Downtown payroll of approximately $3,000,000,000 with an additional input of 23,000 jobs and $250,000,000 annual payroll. As these projects develop, the City anticipates an infusion of over $1 billion in private investment in Downtown and adjacent areas. Improvements to the Artery will strengthen access and other public infrastructure in all of these areas and will assist physical development by including private investments in the core of the region.

Many of the proposed physical changes have been noted in the Corridor Planning Study, and the Artery proposals have been developed in concert with the City. The City of Boston initiated the proposal, and plays a special role through its representation on the Artery Policy Committee and has a uniquely strong role in regional-level policy making through its membership on the Joint Regional Transportation Committee, the Metropolitan Area Planning Council and the MBTA Advisory Board.

Relation to National Policies

Proposals to improve the Central Artery are not only consistent with local, regional and state development policies, but also with federal policies. The Commonwealth's policy for the revitalization of older urban areas has in fact preceded the development of a parallel feature of the Carter Administration's national urban development policy. The present national policy cites Boston as one of its target areas - a city with high unemployment and declining population. Federally-assisted investments in transportation and other areas will be trageted toward revitalizing urban centers so that investments can reinforce one another. In undertaking such an investment policy, the federal goal is to work in partnership with state and regional agencies in furthering locally-defined development goals.

Massachusetts has assisted in the development of policies aimed at reducing urban sprawl and reinforcing the economic vitality of existing urban centers. It has also found means of cooperating

in the planning and implementation of transportation improvements as an integral element in the strategy to encourage economic growth and development while improving environmental quality. Since these are now federal goals, they are supported by city, regional and state commitments to maintain and upgrade the public infrastructure as a positive inducement to private investment, and to increase potential job opportunities. As stated in the National Urban Policy Report, we intend to "use transportation as an incentive program to leverage public and private urban revitalization activities and make urban transportation programs more effective tools to accomplish improved transportation and broad economic, environmental and social goals." Proposed improvements to the Artery mesh closely with these federal goals. In addition, in every instance where federal guidelines or policy directions have been applicable, we have guided or modified our proposals to assure that they are consistent. These include, but not limited to, such varied guidelines and controls as the Environmental Protection Agency Air Quality control provisions, the Coastal Zone Management Porgram, and the Uniform Relocation Assistance and Real Property Acquisition Policies Act.

Conclusion

The proposed improvement of the Central Artery has been advanced within an overall process which has involved all levels of government in Massachusetts. Initiation of the project by the City of Boston has been followed by procedural steps on all levels to assure that the proposal will be thoroughly examined before a final decision is reached. This examination will of necessity be a complex and lengthy process, involving not only the individuals and agencies already included, but many more by the time a decision is made. I am convinced that the process of detailing the implications of Artery alternatives is essential, and that the present documents are substantial evidence of problems which must be dealt with by proceeding to full-scale environmental impact analyses for both the Central and South areas.

Very truly yours,

JOHN J. CARROLL
COMMISSIONER

CENTRAL ARTERY/I-93 CORRIDOR

CENTRAL AREA PLANNING STUDY

Prepared for the Massachusetts Department of Public Works
by the Central Transportation Planning Staff
in conjunction with the MDPW Central Artery Project Staff

March 1978

This report has been prepared pursuant to the requirements of the Massachusetts Action Plan, with the financial assistance of the Federal Highway Administration and the Massachusetts Department of Public Works.

TABLE OF CONTENTS

Chapter I	**Summary of Findings**	
I.A	Purpose	Page 1
I.B	The Central Artery	2
I.C	The Central Artery Corridor	6
I.D	Alternatives to Construction in the Central Artery Corridor	8
.1	Alignments outside the Corridor	8
.2	Analysis of Alignments outside the Corridor	10
I.E	Alternatives within the Present Corridor	10
.1	Alternative Reduction	10
.2	Alternatives for Examination	12
Chapter II	**The Central Area**	
II.A	Description of the Existing Facilities	19
II.B	Central Area System Characteristics	20
.1	Connections for North-South through traffic	24
.2	Connection between the North and the Harbor Tunnels	25
.3	Connection between the South and the Harbor Tunnels	26
.4	Connections between Leverett Circle and the Tunnels	27
.5	Connections between Surface Streets and the Tunnels	28
.6	Connections between Surface Streets and the Artery	29
.7	Connections between Surface Streets via the Artery	31
.8	Composite Artery Connections	31
II.C	Central Area Traffic Service Problems	32
.1	Traffic volumes and conflicts	33
.2	Geometrics of the Present Elevated Artery	39
.3	Service Level Consequences	40
.4	Delays and Queues	44
.5	Accidents	44
II.D	Environmental Conditions	46
.1	Existing Air Quality	46
.2	Existing Noise Climate	51
Chapter III	**Alternatives for Improvement**	
III.A	Alternatives Outside the Artery Corridor	55
.1	Corridor Retention	61
III.B	Alternatives within the Present Corridor	62
.1	Central Area Highway Planning Context	62
.2	Derivation of Alternatives	66
.3	Alternatives for Further Study	68
.4	Relationship to Other Potential Projects	68
.5	Separability of the Central Area	68
.6	Feasible Alternatives	69
.7	Integration with Transit	88
.8	Transit Opportunities	90

TABLE OF CONTENTS (continued)

	.9	Construction Feasibility	Page 94
III.C		Assessment of Impacts	102
	.1	Transportation Operational Improvements	102
	.2	Safety	111
	.3	Regional and Community Impacts	111
	.4	Environmental Impacts	114
	.5	Costs, Construction Duration and Disruption	119
Chapter IV		Public Participation	
IV.A		Process	121
IV.B		Public Involvement Program	121
Chapter V		Conclusions & Recommendations	137

CHAPTER I. SUMMARY OF FINDINGS

I.A PURPOSE

This report is a preliminary overview of engineering and environmental impact studies completed for the Central Area of Boston's proposed Central Artery project and is the basis for detailed future engineering, environmental and related studies.

In the report, the Central Area is described in terms of existing facilities, system characteristics, traffic characteristics, and environmental conditions. Then, alternatives for improvement are presented both in terms of possible construction external to the Central Artery Corridor and in terms of potential actions solely within the Central Area of the Artery Corridor. Subsequently, alternatives outside of the Central Artery Corridor are eliminated from further consideration because of construction, traffic, and/or environmental problems. Attention is then devoted to construction alternatives solely within the Central Area of the Central Artery Corridor.[1]

Nine construction options are described and evaluated, and seven are proposed for further study. Finally, general conclusions and recommendations are reached regarding potential construction in the Central Area. Throughout this report, results are utilized from various analyses performed by the Massachusetts Department of Public Works (D.P.W.) and other organizations.

---

1 Construction options for the South and North sections of the Central Artery Corridor are taken up in separate reports.

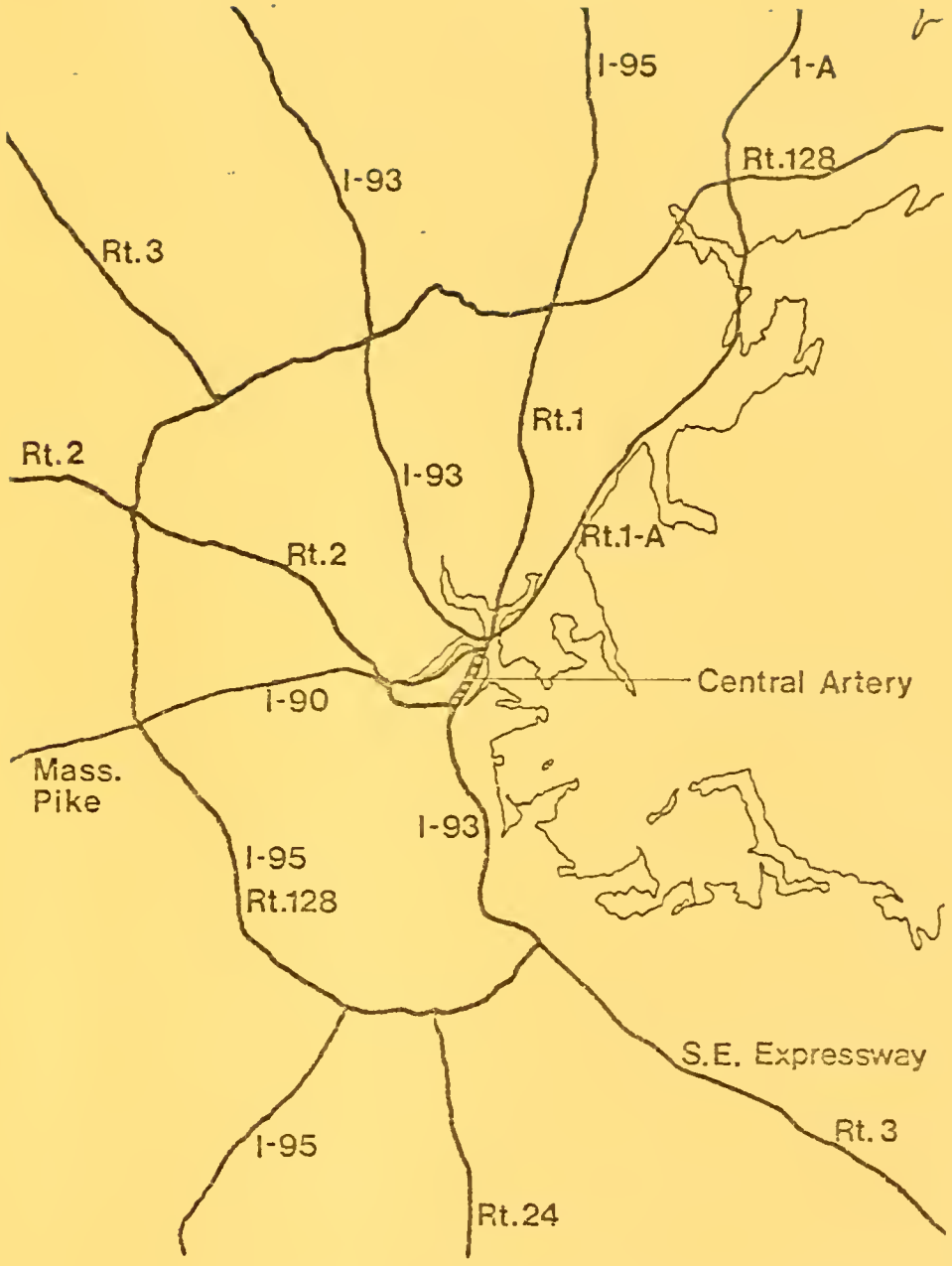
I.B THE CENTRAL ARTERY

The Central Artery (I-93) is a multilane freeway traversing the Boston core area. It stretches in a generally southerly direction from the junction of I-93 and the Mystic River Bridge approach in Charlestown north of downtown Boston, over the Charles River, through downtown Boston, and then south to the interchange between Massachusetts Avenue and the Southeast Expressway just south of Boston's central business district. It is about three miles long. Figure 1 shows the Central Artery in the context of the regional Boston express highway system.

The Central Artery connects with a number of arterial highways along its length. As seen in Figure 2, just south of the Charles River it connects with the McGrath/O'Brien Highway and Storrow Drive which provide service to the northwest and west respectively. In the downtown area itself, the Central Artery connects with the Callahan and Sumner tunnels which provide service to and from East Boston and Logan Airport. In downtown Boston, the Central Artery has connections with many downtown streets. South of downtown, it has a large interchange with the eastern terminus of the Massachusetts Turnpike.

Through its various interconnections, the Central Artery provides access to a number of distinct districts of the Boston central area. Included in the areas served are the financial district, the retail shopping area, the office district, the Government Center, the industrial and seaport areas in South Boston and Charlestown, the industrial areas of East Cambridge and Charlestown, the North End, the North Station area, the Waterfront, Chinatown, the South End, West End, South Cove and South Boston residential areas.

When the Central Artery was constructed in the 1950's, it was conceived as the most important link of the full expressway network proposed in the 1948 master highway plan for the Boston area.



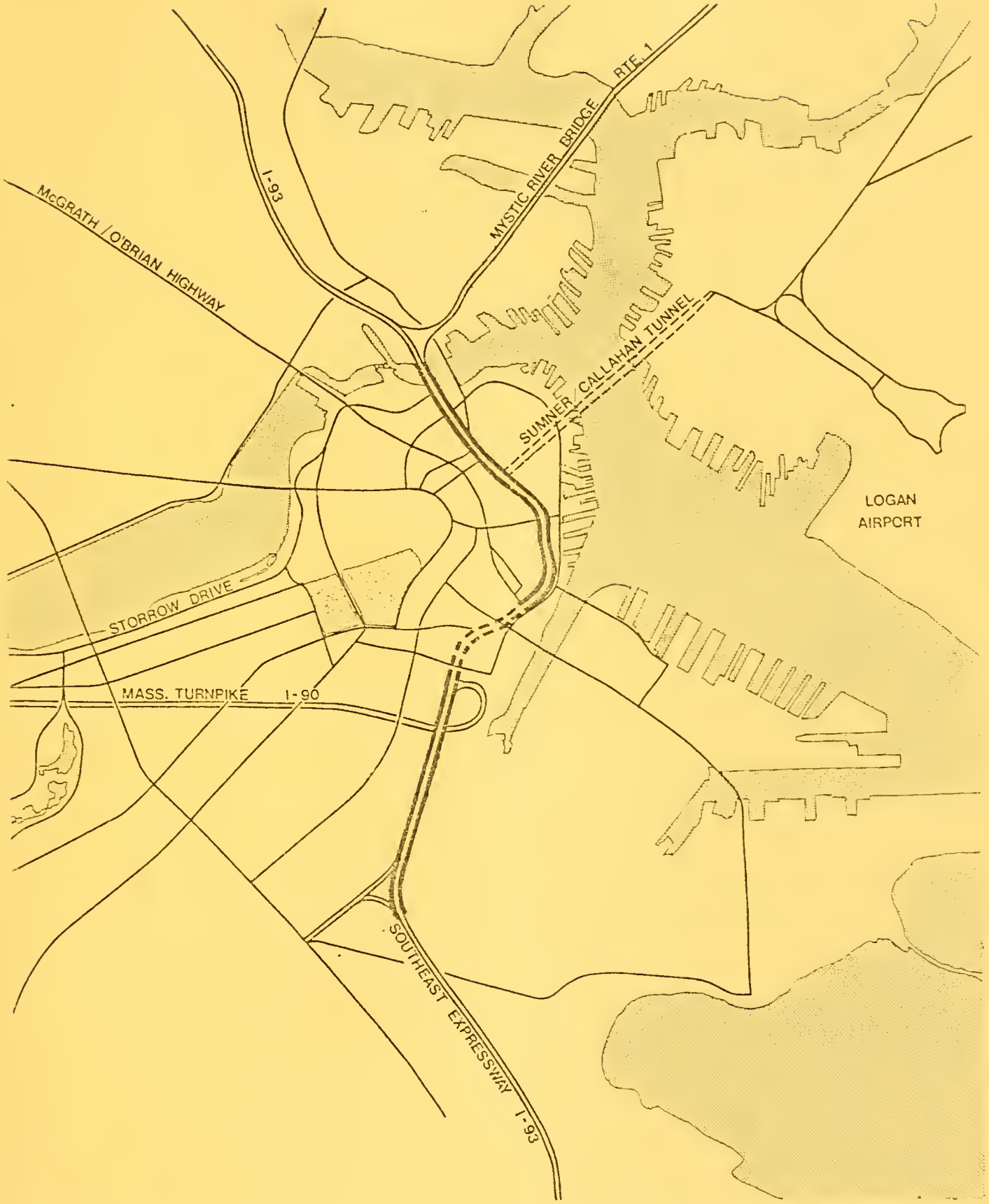
REGIONAL NETWORK Figure 1

Because the Central Artery was built before the Interstate highway program, it was built without Federal assistance, and its capacity and design were restricted. As a result of insufficient

capacity - generally the Central Artery is a six lane facility - it acts as a bottleneck both to the north and to the south. At its northern terminus, five lanes from I-93 merge with five lanes from the Mystic River Bridge to form a facility of only six lanes across the Charles River. At the south end of the Central Artery, six lanes from the Southeast Expressway and six lanes from the Massachusetts Turnpike also merge together in a facility only having six lanes. Traffic going from and to other major roads along the Central Artery compounds the problems caused by the Artery's insufficient capacity.

From a design point of view, the Central Artery is also inadequate by modern standards. In its three mile length, it has no breakdown lanes. It also has a total of 42 ramps, 25 for local service, and 17 for connections to expressways, the Mystic River Bridge, and the tunnels. Because of the lack of breakdown lanes, any traffic incident in either roadway, even a stalled vehicle, diminishes effective capacity in the direction affected by at least one third. Because of the original design, the ramps are also inadequate, having insufficient speed change lanes and sightlines. This results in severe safety hazards and further diminishes the effective capacity of the Central Artery roadway. In addition, the closely spaced ramps cause conflicts with through traffic. Some ramps use surface streets for through expressway traffic which conflicts with surface traffic and pedestrians. Finally, much of the Central Artery is an unsightly elevated structure which is generally regarded as a blighting influence on downtown Boston with severe aesthetic and other negative environmental impacts.

In addition to these problems, it is apparent that the decks of the Artery must be replaced by 1984-1989. These concerns have led to several Central Artery studies, including the current ones, all developed to determine how best to address the deficiencies of the facility.



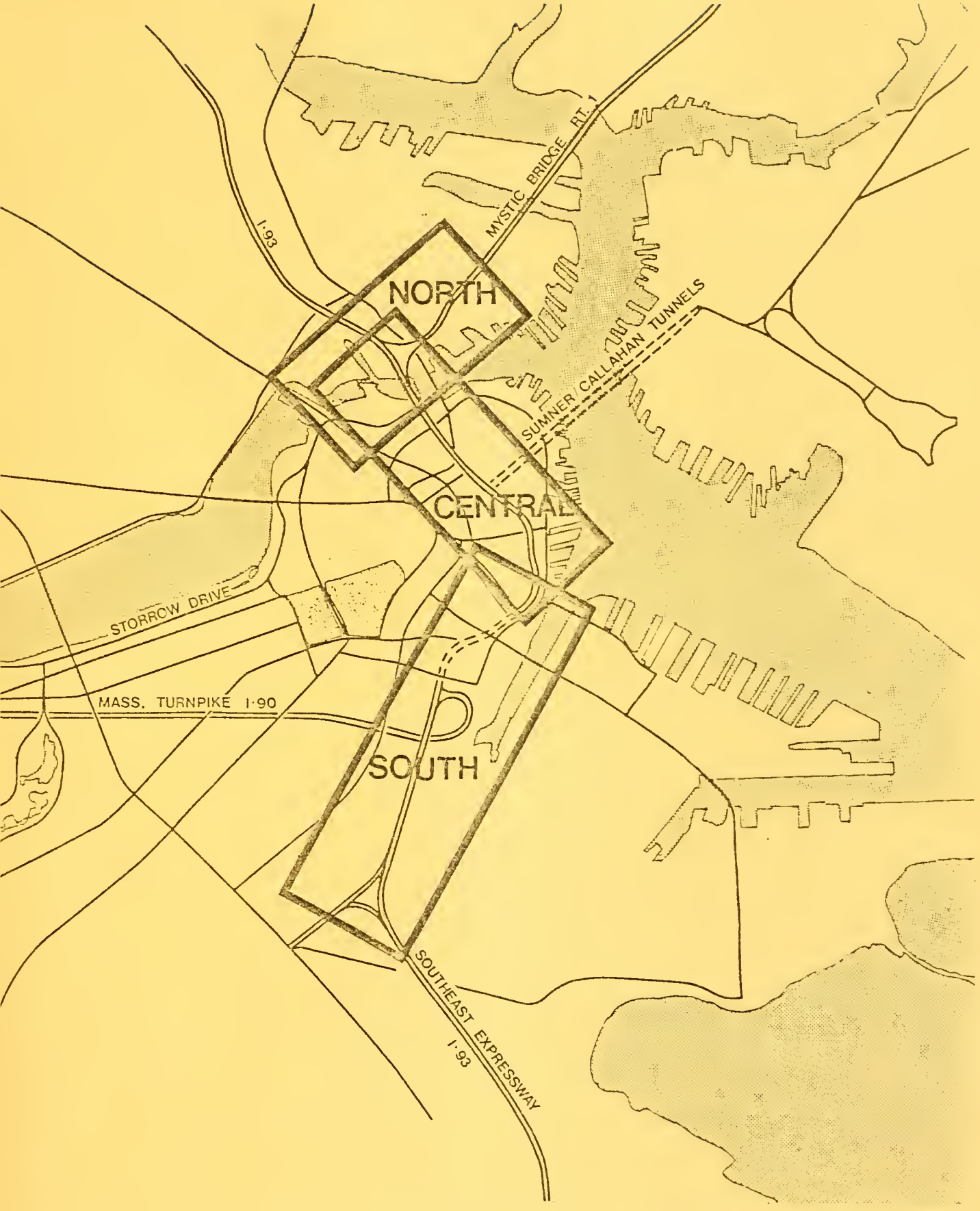
CENTRAL ARTERY

Figure 2

I.C THE CENTRAL ARTERY CORRIDOR

For purposes of planning, the Central Artery Corridor has been defined as the area stretching roughly half a mile on either side of the Central Artery roadway, and a similar distance beyond each end of the Artery. As such, the corridor encompasses the entire area that is likely to be physically affected by potential Central Artery reconstruction. The area of the corridor includes about half of Charlestown, most of downtown Boston, and portions of the South End and the industrial area of South Boston.

Figure 3 shows the three designated subareas of the Central Artery Corridor: North, Central, and South. These areas have been defined to help plan and advance Central Artery improvements in sub-sections that are both analytically manageable and financially feasible. From an analysis point of view, this definition of subareas is helpful because it allows greater focus on alternatives and their impacts. From a financial point of view, this provides a basis for realistic assessment of the probable sequencing of funding and construction timing for potential project elements. It also allows potential improvements to be made on varying time schedules and expenditure levels. Geographically, the Artery also divides naturally into North, Central, and South sections with largely separable functions and physical features. Thus potential improvements to the different sections, while fitting together in a unified structure, nonetheless have individual benefits and can be constructed independent of one another.



ARTERY CORRIDOR STUDY AREAS

Figure 3

I.D ALTERNATIVES TO CONSTRUCTION IN THE CENTRAL ARTERY CORRIDOR

Several alternatives to construction in the Central Artery Corridor have been explored in various studies. These have been extensively reexamined and found to be inadequate to solve the various operational and safety problems of the Artery. These alternatives are described below and illustrated in Figure 4. All have been dropped from further consideration.

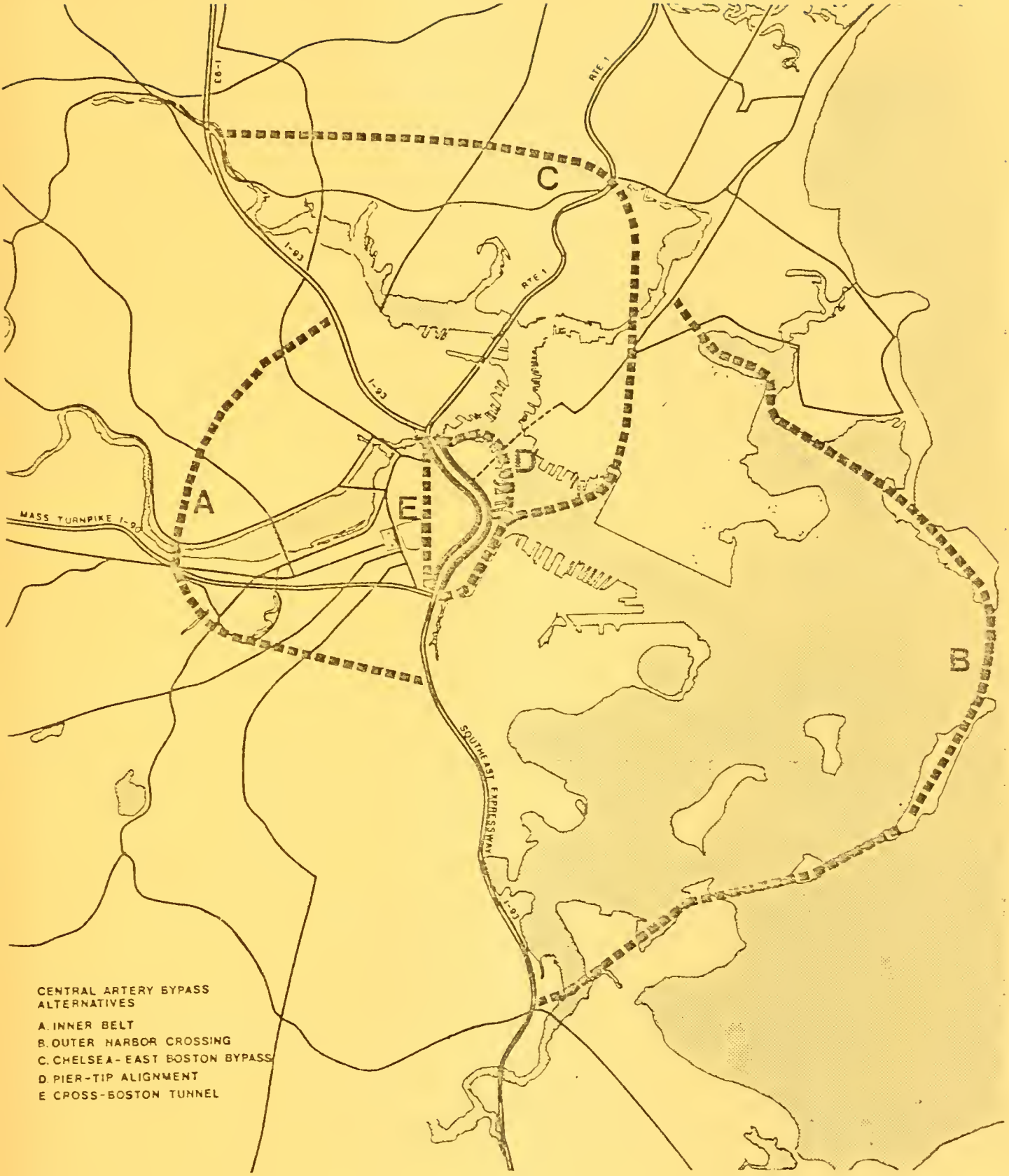
I.D.1 ALIGNMENTS OUTSIDE THE CORRIDOR

1. The Inner Belt. This option was ruled out by governor Sargent in 1971 for these reasons: residential takings and relocation requirements, community disruption, community protest, technical questions regarding ability to accommodate projected traffic volumes, and generation of additional traffic for the Boston core area.

2. Outer Harbor Crossings. This proposal for a highway from Quincy to Winthop via the harbor islands and a combination of bridges and causeways was ruled out because of environmental impacts, intrusion into the flight paths of Logan Airport, inadequate provisions for connections to other expressways, and lack of downtown collection and distribution relief.

3. Chelsea/East Boston Bypass - This option from I-93 North via Chelsea and East Boston to a tunnel under the harbor was ruled out, among other reasons, because of residential takings and relocation requirements, community disruption, impacts on shipping in Chelsea Creek, the necessity of a tunnel under East Boston, and partial dependence on I-95 in Lynn (dropped in 1972) and the proposed I-95 Relocated in Revere (dropped in 1972). The tunnel under the harbor is the proposed Third Harbor Crossing, a part of the projected ultimate regional expressway network. It is considered in this report as it relates to South Area studies.

4. Pier Tip Bypass - This alternative would consist of a highway from Charlestown to South Boston via a harbor tunnel



ALTERNATIVES TO THE ARTERY CORRIDOR

Figure 4

along the tips of the downtown piers. It has been eliminated from further consideration because of the lack of necessary connections with the Sumner-Callahan tunnels, steep grades, and difficult design and engineering problems including ventilation and interconnections with other expressways.

5. Cross Boston Tunnel - This option includes a tunnel from Charlestown to South Station under Beacon Hill, the Boston Common, and the downtown Boston retail area. It was ruled out because of technical infeasibility, questions of grades and ventilation, lack of interconnections with expressways, failure to connect with the Sumner-Callahan tunnels, and lack of collection/distribution services.

I.D.2 Analysis of Alignments Outside the Corridor

Analysis of solutions to the Central Artery problems by construction outside the corridor yields several major conclusions. First, technically and socially acceptable alternative alignments to provide for Central Artery functions cannot be found outside of the corridor. Second, the present corridor is the only one that can effectively connect with all of the expressways and tunnels, and also serve downtown collection/distribution needs.

For these reasons, and because extensive deck repairs must be made in the elevated portions of the present Central Artery regardless of whether other improvements are undertaken, it is appropriate that specific alternative improvement projects be developed for the Central Artery corridor. In accordance with normal highway planning practice, the alternatives include the "no-build" option, which would, as a minimum, provide for necessary bridge deck replacement.

I.E ALTERNATIVES WITHIN THE PRESENT CORRIDOR

I.E.1 Alternative Reduction

Land uses and proposed community improvements were examined in conjunction with transportation problems in the Central Area. Con-

straints imposed by the need to plan improvements within the existing corridor and to minimize impacts on surrounding areas led to two classes of alternatives. The first group provides for improvement along the present alignment. This includes the no-build option, widening of the present viaduct, and double-decking. In all cases, traffic in both directions would continue to use the present alignment with proposed modifications.

The second class of alternatives is reconstruction of the Central Artery in a tunnel. With the Artery in a tunnel, there could be a transit way in the median. In order to narrow alternatives, each of these groups were analyzed in some detail.

Improvements Along the Present Alignment

This set of improvement options centers on the existing viaduct in the Central Area.

Reconstruction Alternatives

This set of improvements possibilities centers on the use of tunnels carrying one or both directional movements to relieve the problems of the present viaduct.

Of these possible alternatives, the no-build options should be examined in further analyses, along with selective widening to afford operational improvements. Double-decking the present facility is to be dropped because of excessive impacts. Tunneling for one-directional movements will be examined as a possible staging technique for larger-scale reconstruction. Tunneling for all movement will be retained for detailed analysis.

The remaining options have been extensively examined in conjuction with other possible projects in or connecting to the Corridor. In all instances, it has been assumed that the North Area Project will be undertaken; without it,

the proposed alternatives for the Central Area cannot be undertaken.

The remaining possible projects which influence decisions in the Central Area of the Artery Corridor are:

1. The proposed improvements in the South Area of the Artery Corridor.

2. The suggested Third Harbor Tunnel between Downtown and Logan Airport: if constructed, this project would connect only to Logan Airport. It has two possible forms of services:

   a. A special purpose tunnel, serving only buses, trucks, taxis and emergency vehicles to and from the Airport.

   b. A general purpose tunnel serving all vehicles to and from the Airport.

3. The proposed transitway between North Station and South Station. This proposal is included in all alternatives for reconstruction of the Central Area of the Artery Corridor.

I.E.2 Alternatives for Examination

The alternatives which result from combining the options for the Central Area of the Artery Corridor are illustrated in the following figure:

Figure 5: Central Area Alternatives

	Without 3rd Harbor Tunnel	With 3rd Harbor Tunnel	
		Special Purpose	General Purpose
No Build	Alt. 1	Alt. 2	Alt. 3
Reconstruction Without South Area With Transitway	Alt. 4	Alt. 5	Alt. 6
Reconstruction With South Area With Transitway	Alt. 7	Alt. 8	Alt. 9

Alternative 1 - The No Build Alternative

The No Build Alternative would retain the existing elevated facility, with some modifications to it. The existing structure was erected in 1954-9. The decks of the existing structure will require replacement by 1984-9 to correct deck deterioration from the combined effects of approximately 30 years of heavy traffic and the annual applications of calcium for snow removal. There are three methods of undertaking this work:

a. Rebuilding of one lane of the deck at a time;

b. Selective ramp rebuilding, replacement or addition prior to rebuilding of one lane of the decks at a time;

c. Selective widening of the Artery where possible to allow rebuilding of two lanes of the decks at a time, without loss of existing capacity.

Any of these No Build Options can be constructed with or without the proposed North Area project in the Artery corridor.

Alternative 2 - The No Build Alternative With a Special Purpose Third Harbor Tunnel

Alternative 2 is similar to Alternative 1 in all respects except its relation to a Special Purpose Tunnel across the Harbor. Alternative 2 is feasible with or without the South Area Artery project.

Alternative 3 - The No Build Alternative With a General Purpose Third Harbor Tunnel

Alternative 3 is identical to Alternative 2 in all respects except its ability to divert traffic from the Central Area of the Artery. Through construction of a general purpose tunnel to the Airport, traffic from the south and west now using the Central Area of the Artery Corridor may be diverted.

Alternative 4 - Reconstruction of the Central Area of the Artery Without the South Area or Third Harbor Tunnel

Reconstruction of the Central Area of the Artery may be desirable to maximize needed transportation and environmental improvements. The major issues of Alternative 4 would be to construct a tunnel within the existing Artery right-of-way. It would provide three lanes in each direction, with the shoulder used in peak periods to accommodate traffic demand. The tunnel would serve not only as a highway facility but the potential exists also for a transit facility.

Two major construction techniques are:

a. Reconstruction by erecting temporary oneway facilities that allow removal of half the Artery lanes and structure while constructing half of the new tunnel at a time;

b. Construction of a tunnel beneath the existing elevated Artery structure; the existing facility is maintained for traffic until sufficient tunnel construction is completed to allow diversion of traffic from the elevated highway. With traffic in the new tunnel, the existing structure is removed, and the new tunnel widened to full width.

Both of these options are feasible; however, Option (b) provides for less disruption to existing traffic and of equal importance, considerably less land damages during the construction period. It also appears to offer fewer disruptions not only to traffic but to the adjacent areas.

The transitway between North and South Stations is a principal component in all reconstruction options. In Option (a) above, it is added when construction of the Artery tunnel is completed. In Option (b) above, the transitway tunnel is in the median of the new highway tunnel and therefore forms an integral portion of the proposed facility.

Alternative 5 - Reconstruction of the Central Area of the Artery Without the South Area Project With the Special Purpose Third Harbor Tunnel

Alternative 5 is the same as Alternative 4, with the exception that the Third Harbor Tunnel would be constructed in the Fort Point Channel as a unit having no reference to the South Area of the Artery Corridor. If constructed in this manner, the Third Harbor Tunnel would preclude subsequent improvements to the South Area of the Corridor.

Alternative 6 - Reconstruction of the Central Area of the Artery Without the South Area Project With the General Purpose Third Harbor Tunnel

Alternative 6 is the same as Alternative 5, with the exception that the Third Harbor Tunnel would be constructed as a general purpose facility.

Alternative 7 - Reconstruction of the Central Area of the Artery With the South Area Project

Alternative 7 is the same as Alternative 4, but it includes improvements in the South Area of the Artery Corridor.

The construction of a new Atlantic Avenue or Fort Point Channel Tunnel as part of South Area improvements would alleviate the transition of traffic into the new facilities during the construction period.

Alternative 8 - Reconstruction of the Central Area of the Artery With the South Area Project and With the Special Third Harbor Tunnel.

Alternative 8 is the same as Alternative 7, with the addition of the Special Purpose Harbor Tunnel to the Airport. The connection between the Third Harbor Tunnel and the South Area Project would take place in the vicinity of Northern Avenue.

Alternative 9 - Reconstruction of the Central Area of the Artery With the South Area Project and With the General Purpose Third Harbor Tunnel

Alternative 9 is the same as Alternative 8, with the addition of the General Purpose Harbor Tunnel to the Airport. As in Alternative 8, the connection between the Third Harbor Tunnel and the South Area Project would take place in the vicinity of Northern Avenue.

Conclusions

1. Work will have to be done on the Central Area of the Artery Corridor within the next 10 years, to replace the existing decks that have been subjected to nearly 30 years of continuous loading and chemicals from snow removal.

2. Given the scale of disruption which will accompany the replacement of the decks in the Central Area of the Artery, consideration must be given to alternatives which may address the functional problems of the Artery as well as the potential disruption from construction.

3. There are no feasible alternatives to the present Artery Corridor which can solve the problems of disruption during deck rebuilding or which are suitalbe corridors for permanent new facilities.

4. A series of alternatives within the Artery Corridor has been examined. These fall into two classes: retaining the existing structure and construction of new tunnels.

5. A number of alternatives appears to be feasible (See Figure 5). Of these alternatives, some appear to offer substantially greater potential than others to address the transportation and construction problems of the Artery.

6. The remaining Alternatives 1, 4, and 7 should be studied in detail. Alternatives which should not receive

any further examination are Alternatives 2, 3, 5, 6, 8 and 9.

7. Alternatives 1, 4, and 7 have inherent flexibility to accomodate the Third Harbor Tunnel while serving Central Area needs. The Third Harbor Tunnel serves purposes and has benefits that are different from reconstruction of the Central Artery. It should be retained as part of the long-range plan. It is feasible to proceed with the reconstruction of the South Area of the Artery Corridor in advance of the Third Harbor Tunnel.

   As the Third Harbor Tunnel is not an integral part of the Central Artery, detailed study of design, costs and impacts of it should proceed separately from the Artery project.

8. Major reconstruction of the Central Area of the Artery offers the possibility of implementing a long-range strategy for the improvement of the economic future of Downtown Boston.

9. Questions which should receive special attention during analysis of remaining alternatives are as follows:

   a. All alternatives require detailed analysis of:

      - construction techniques and phasing
      - traffic control during construction
      - transportation service
      - demand/capacity analysis
      - surface street impacts
      - relation to harbor crossing demand and airport service
      - safety during and after construction
      - air, noise, and water quality impacts
      - economic impacts (regional and local) during and after construction
      - social impacts to adjacent neighborhoods and the region, during and after construction
      - land use and urban design considerations
      - detailed cost estimates
      - employment generation
      - land damages

b. Reconstruction alternatives require, in addition, detailed analysis of:

- ventilation requirements
- joint development and overbuilding opportunities
- deck requirements
- tunneling requirements
- dangerous cargo handling
- joint rail line construction
- rail line service, space requirements

CHAPTER II THE CENTRAL AREA

II.A DESCRIPTION OF THE EXISTING FACILITIES

The Central portion of the Artery corridor is the downtown elevated highway that provides both local and through service to the core of the Boston region. It links I-93 , Route 1 and Storrow Drive on the north of Downtown, the harbor tunnels between Downtown and the Airport, and the Southeast Expressway and Massachusetts Turnpike to the South. This portion of the Artery carries volumes in excess of 135,000 per day and serves a range of highway connections not duplicated in the region inside Route 128.

This portion of the Artery was built between 1954 and 1959 and was constructed with state funds. It was constructed using the engineering standards of the time, as the Federal Interstate Highway Program had not yet begun. The decision to build an elevated facility was determined by considerations of passing over the Charles River and the Causeway Street elevated transit Line which has since been removed.

The Artery was designed to serve both expressway connections and downtown access. A combination of ramps to surface streets and to other major highways was provided. Because of its elevated configuration, the Artery was built without breakdown and speed change lanes. Highway curvature and sight lines are restrictive and the short distances between ramps lead to difficulties in merging and weaving traffic. The connections between the Artery and the harbo tunnels uses local surface streets for ramps connections between the Callahan Tunnel (Northbound) and the Sumner Tunnel (Southbound). These surface streets are located in an area of heavy congestion between the North End and the Haymarket and newly developed Quincy Market complex.

The setting of the Artery is a corridor which once was the edge of Downtown between the Waterfront and the active retail and financial districts. Since it was built, major new developments have occurred as a result of public actions and private investment. The

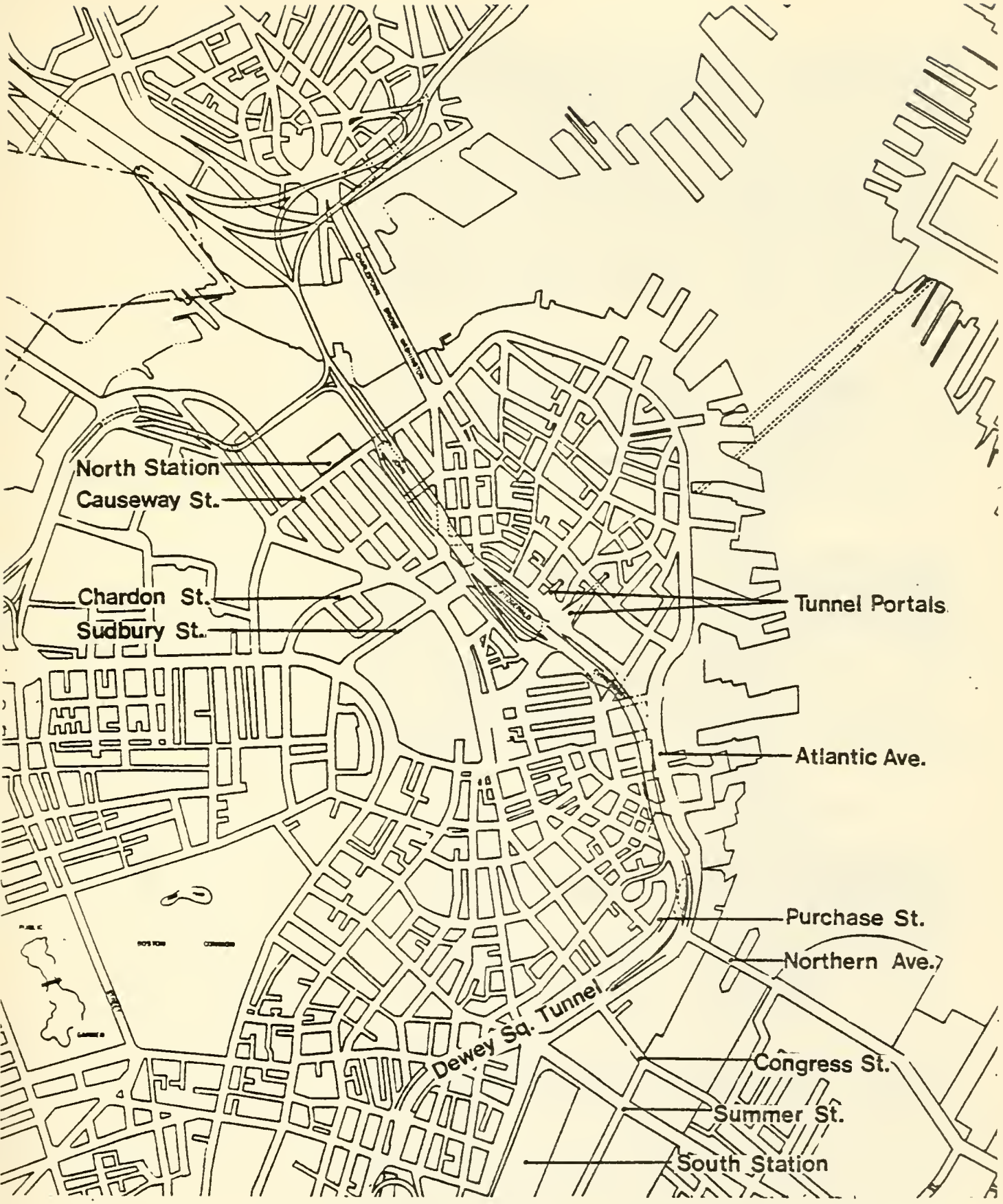
most impressive of these is the Waterfront/ Government Center renewal projects. The renewal effort has resulted in the successful recycling of the Fanueil Hall--Quincy Market buildings into a new commercial center, and the provision of a large new focus housing governmental functions for state and federal agencies.

Historic districts and sites along the Artery include the Broad Street (Custom House) historic district and numerous individual sites throughout Downtown. The residential area of the North End has become recognized as a valuable cultural and historic area with a close-knit community which contributes to the vitality of Downtown. In addition, its commercial activities serve both a local and regional market.

Institution of the renewal projects and the recognition of historic resources have occurred since the construction of the Artery. As these developments reach completion, the impacts of the Artery have become more apparent. Whereas the Artery once formed an edge of active Downtown areas, it is now more nearly surrounded by vital portions of Downtown. Esthetic values have changed since the Artery was built, and the community around it has developed to the point where Artery impacts have become a greater negative influence. Community character is greatly affected by the Artery, especially at a time when public and private efforts are being made to stablilze and enhance business and residence dissricts along the right-of-way.

II.B CENTRAL AREA SYSTEM CHARACTERISTICS

The Central Portion of the Artery has always served as a key link in the network of expressways serving the Boston Region. As conceived in the 1948 highway master plan, the Artery was the major through connection in the heart of Downtown. It was planned to operate in conjunction with the Inner Belt in providing distribution to downtown from the network of radial expressways and to provide interconnections between expressways. Over the years the traffic carried by the Central Portion of the Artery has built up substantially beyond the original predictions, and the mix of



CENTRAL AREA STREET SYSTEM

Figure 6

functions it serves has made it increasingly difficult to provide acceptable service levels for through traffic. The Artery is now designated I-93 and its Central portion is the downtown link between I-93 north - a major radial route extending to Route 128 and beyond - and I-93 south (the southeast Expressway) which provides a radial route to Route 128, where it connects with both Route 3 to Cape Cod and I-95 to the south. All of the radial highways leading into the core of the region are now completed and no new radial capacity will be added.

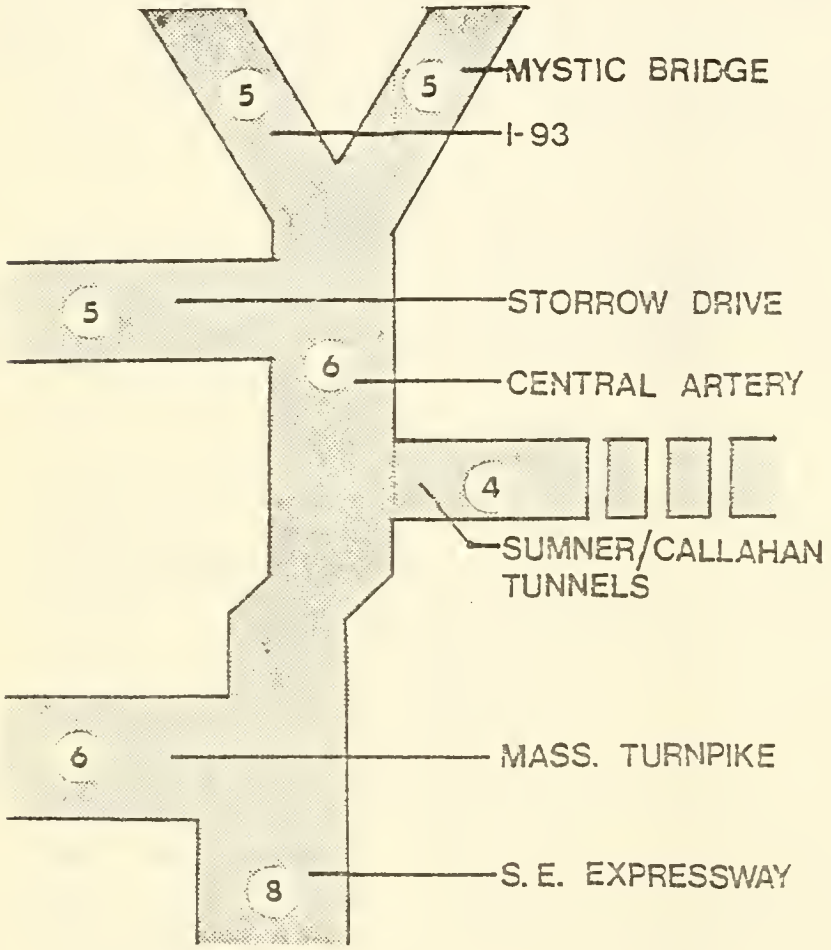


Figure 7: Expressway Lanes Entering and Leaving the Central Artery

At present the problems of the Central Artery have been defined as occurring in three geographic areas: the North Area, where the Mystic Bridge and I-93 join before entering the Central Portion of the Artery and the South, where the Massachusetts Turnpike and

the Southeast Expressway (I-93) join before entering the Central portion of the Artery. The Central Portion of the Artery is thus the main connection between the North and the South areas, but in addition must serve additional connections - Storrow Drive, the harbor tunnels, to Logan International Airport and East Boston, plus the downtown street connections. The result of these connections between major expressways is that approximately 50 percent of the traffic on the Artery is through traffic.

Figure 7 illustrates the lanes of each of the major expressway routes connecting into this portion of the Artery. Much of the traffic is composed of vehicles making trips which cannot be served adequately by transit, or trips which are difficult to make by transit because of inconvenient or time-consuming transit

In addition to through movements, the Artery serves connections to major streets in Downtown, both for connections to the expressway network, a bypass route for congested surface streets, and for access to downtown residences, work places and commercial activities. The combination of functions the Artery serves results in at least seven distinct types of movements taking place on the relatively short roadway:

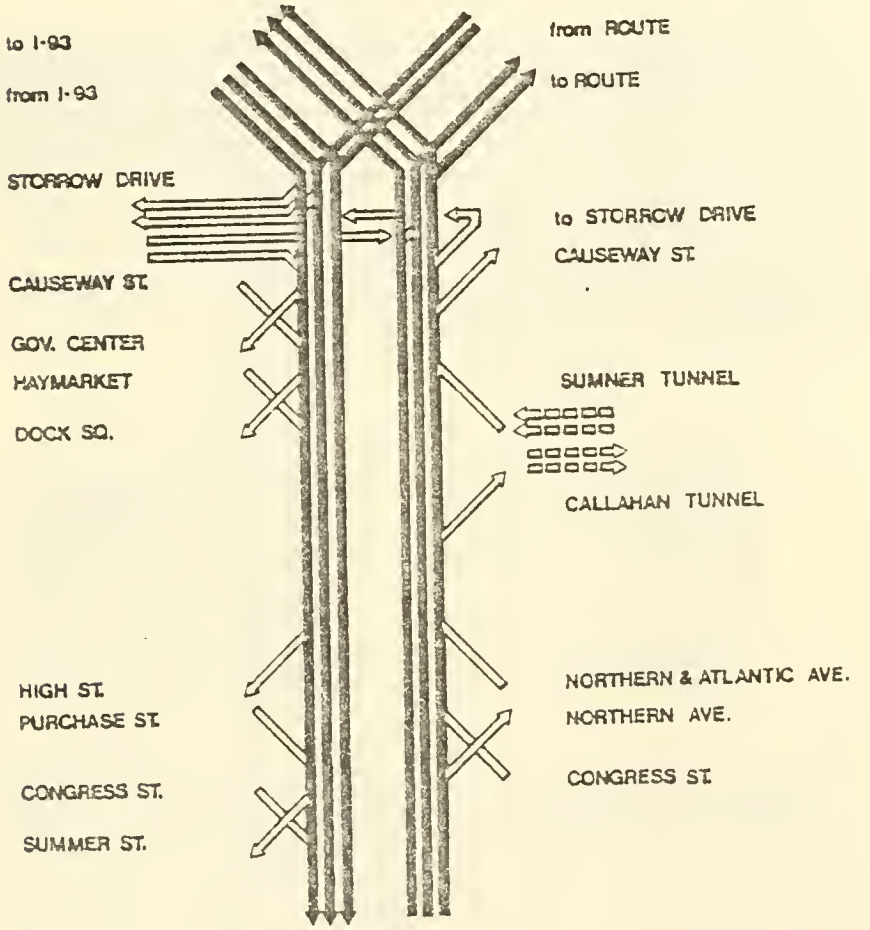
1. Connection for North-South through traffic.
2. Connections between North and tunnels
3. Connections between South and tunnels
4. Connections between Leverett Circle and tunnels
5. Connections between surface and tunnels
6. Connections between surface and artery
7. Connections between surface and surface.

The connections listed above take place within a physical distance of only 4000 feet. The interconnections have therefore been isolated in order to identify the contribution which each makes to the problems of this portion of the Artery. In turn each of these components must be addressed to find solutions to the present problems of the Artery.

Connections for North-South through traffic

The Central portion of the Artery is designated Interstate 93--the major north-south interstate facility in the Boston Region. However, at the north and south entrances to Downtown, I-93 is joined by major expressways--on the North by Route 1 (the Mystic River Bridge), and on the South by the Massachusetts Turnpike (Route I-90). Therefore, the Central Portion of the artery is in fact providing connections between four major expressways: I-93 north and south, Route 1, and I-90. Connections between these expressways cannot be made anywhere else in the region, except for Route 128. The majority of these trips are not divertable to Route 128.

Figure 8 NORTH-SOUTH THROUGH CONNECTIONS

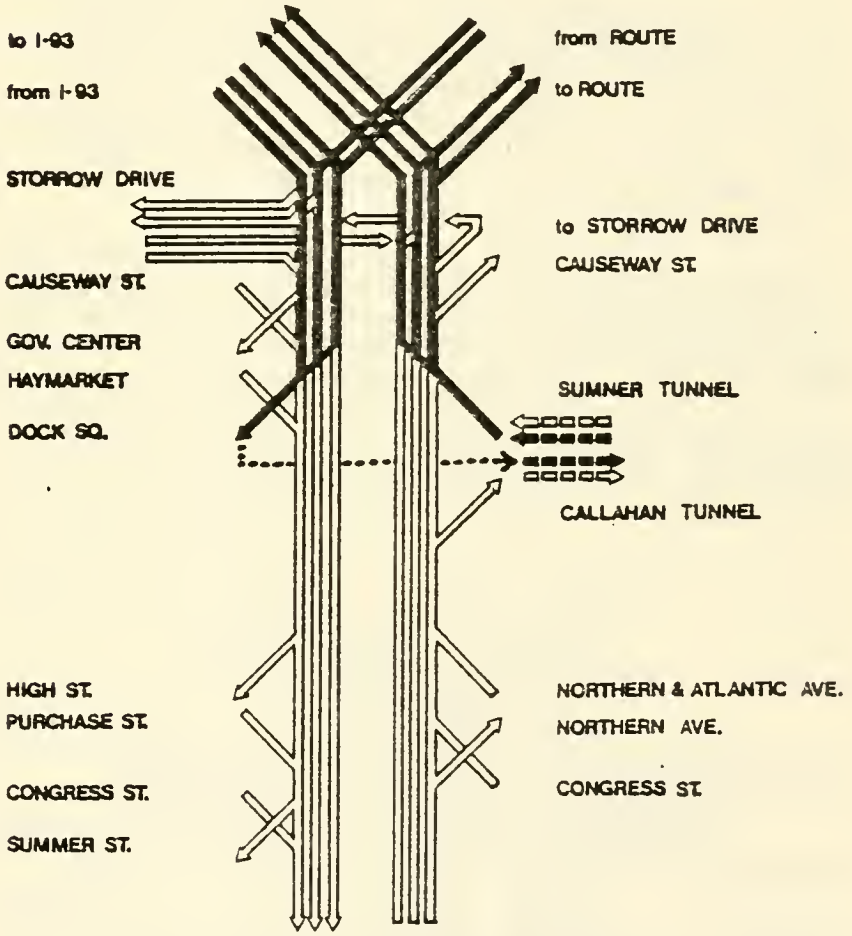


These connections are compounded by other expressway connections entering the Artery within the Central Area: the Harbor Tunnels and Storrow Drive. The combination of interconnections causes significant capacity restrictions.

Connection between the North and the Harbor Tunnels

The harbor tunnels--the Sumner (inbound) and Callahan (outbound) provide major access between East Boston (and Logan International Airport) and Downtown Boston. The tunnels

Figure 9 TUNNELS - ARTERY NORTH CONNECTIONS



are not connected directly with the expressways; local streets are used to provide all interconnections. All traffic from the north on I-93 and Route 1 must use the Harbor Tunnels for access to the Airport and East Boston. The only exception is for traffic from the North Shore, which can use Route 1-A for this purpose. However, 1-A is not an acceptable alternative for traffic from I-93 because of the indirect routing required to reach the facility.

Traffic to the tunnels from the North must exit onto local streets and pass through a

traffic signal, mixing with both local traffic and traffic from the south (I-93), to enter the tunnels. Access from the tunnels to the north is more direct, but requires traffic to mix briefly with locally bound traffic.

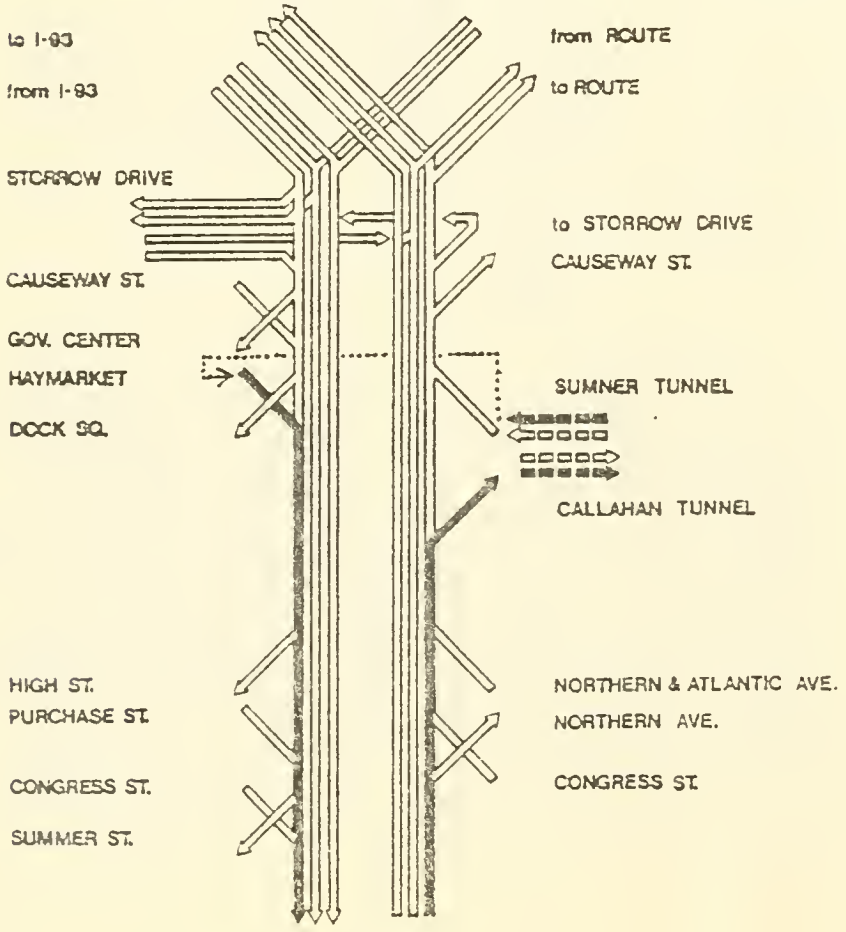
II.B.3

Connection between the South and the Harbor Tunnels

Traffic to the tunnels from the South must exit from the elevated Artery onto the surface plaza immediately in front of the tunnel mouth. This connection is direct however, at the tunnel entrance, traffic must compete with vehicles from the surface and vehicles from the North to enter the two-lane tunnel.

Vehicles exiting the tunnel must merge with a local street (Cross Street), travel north 560 feet, then circle under the elevated Artery and join surface traffic on a ramp to the elevated Artery. This move includes traffic signals on Cross Street, and many intersecting local streets.

Figure 10 TUNNELS - ARTERY SOUTH CONNECTIONS



Connections between Leverett Circle and the Tunnels

Leverett Circle at Storrow Drive is a major surface rotary with ramps directly connected to the artery. The Circle connects several major facilities:

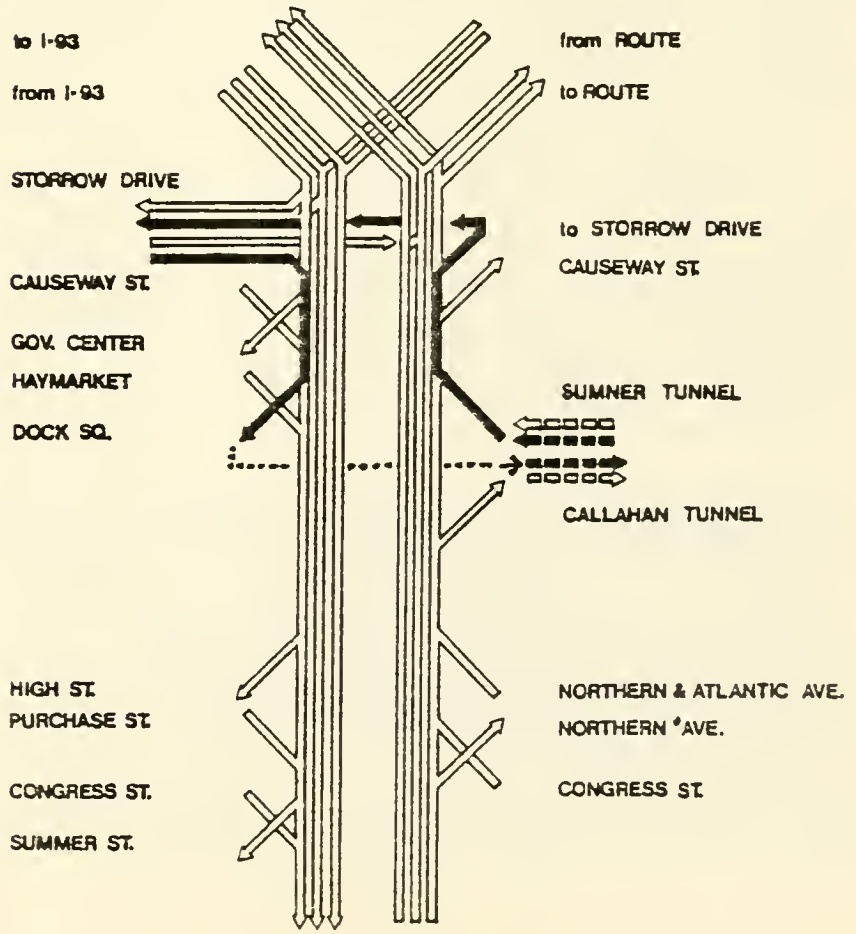
1. Storrow Drive - the expressway to the west.

2. McGrath/O'Brien Highway connecting north to Memorial Drive and the Prison Point Bridge.

3. Local streets - connecting to and from the North Station and Government Center areas.

The ramps from Leverett Circle join the Artery immediately south of the Charles River Bridge of the Artery, and lie between the North Area expressway connections and the major expressway access to and from the Harbor Tunnels.

Figure 11 TUNNELS-LEVERETT CIRCLE CONNECTIONS



Traffic exiting from Leverett Circle to the Artery is served by one lane which merges with two lanes serving traffic from the north; 570 feet after this merge, a ramp leads off the Artery to Haymarket Square. 780 feet after this diverging ramp, the ramp leads onto the Artery from Causeway Street, and 450 feet later, the ramp to the Callahan Tunnel leads off the Artery. In the reverse direction, traffic from the Sumner Tunnel passes through local streets briefly, enters the Artery, passes the off-ramp to Causeway Street at 570 feet and reaches the off-ramp to Leverett Circle at an additional 570 feet. These extremely short distances between ramps in this area cause many conflicts and delays to traffic-especially during peak hours.

II.B.5

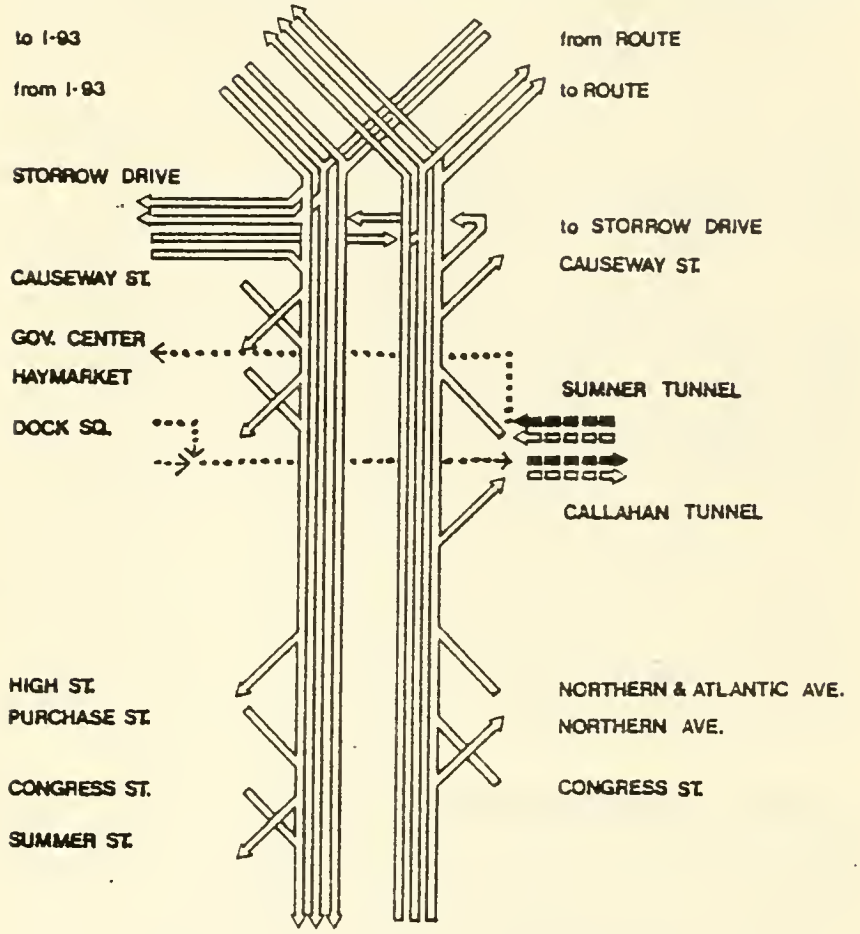
Connections between Surface Streets and the Tunnels

Access between Downtown local streets and the tunnels serving East Boston and the Airport must mix with all expressway traffic to and from the Artery in reaching the tunnel mouths. The access from local streets is further complicated by passage through the congested produce market and the busy Quincy Market complex, with extensive pedestrian and vehicular conflicts.

All connections from the tunnels into Downtown local streets must pass through Cross Street adjacent to the North End which is lined with shops and parked vehicles. Major pedestrian crossings require a signalized intersection on Cross Street, which frequently backs up traffic into the tunnels particularly during rush hours.

Vehicles must pass under the Artery and through the Haymarket area on local streets to gain access to other local streets in Downtown. A particularly difficult move is the connection between Blackstone Street and the surface Artery southbound, which involves crossing traffic from the downtown on North Street into the Tunnels.

Figure 12 TUNNELS - SURFACE STREET CONNECTIONS



II.B.6

Connections between Surface Streets and the Artery

In addition to its service to through traffic the Artery serves the function of connecting surface streets to the expressway network. Serving these functions is difficult and conflicts with all through movements.

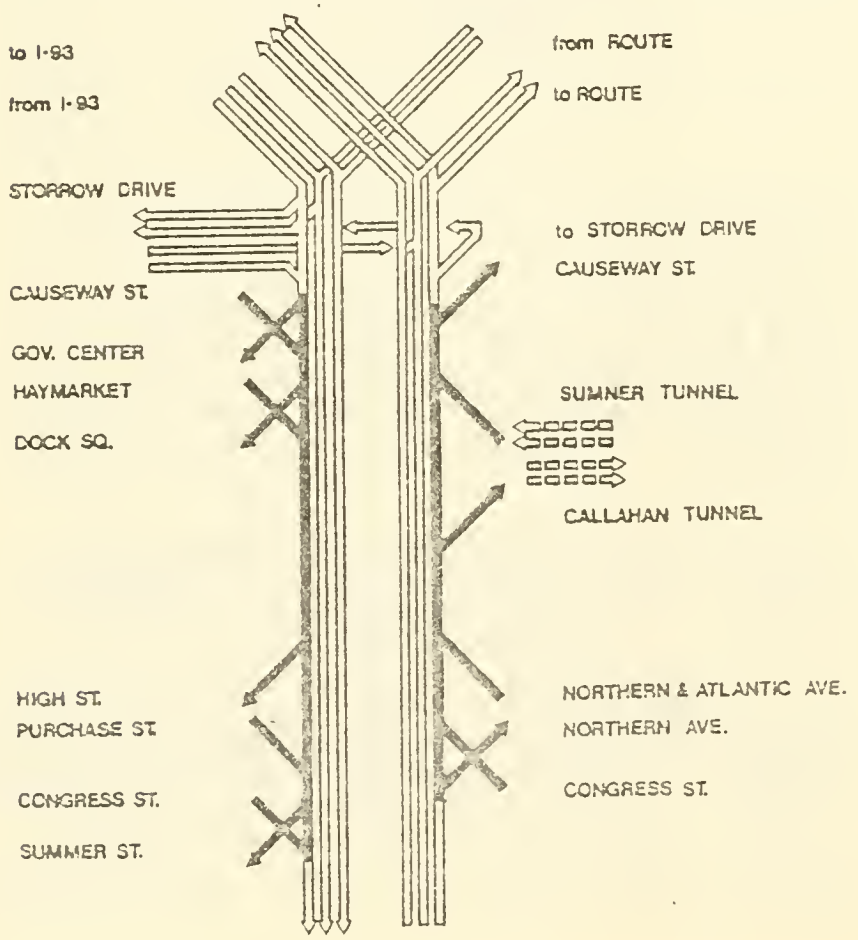
The major points of access between the Artery and the Surface are: 1. Northern Avenue; 2. North Street: 3. Causeway Street; 4. Haymarket Square.

The Northern Avenue area is served by four ramps connecting with the Artery. These ramps connect to and from Northern Avenue at Atlantic Avenue in the northbound direction; however, in the southbound direction, the ramps lead to High Street and from Purchase Street. The connection at High Street is so arranged

that it does not provide for full connections in all directions. This set of ramps is particularly important for service to and from the Financial District and portions of South Boston and the Waterfront.

The next series of local ramps are in the vicinity of the Tunnel mouths at Haymarket. They include ramps to and from North Street, and all other access must pass through North Street for this connection. This series of ramps is the major access point from the Government Center Area and also provides service to parts of the Financial District and Beacon Hill, the West End and portions of the North End. This area is most deficient in terms of local access to and from the Artery and is the area with the greatest number of conflicts between through and local traffic. Particularly severe connections occur on Cross Street and Blackstone Street because of the many moves between local streets, the tunnels and the Artery which occur there.

Figure 13 CENTRAL ARTERY - SURFACE STREET CONNECTIONS



The third series of local ramps are located at Causeway Street. These ramps connect only to and from the South, and provide access to the North Station/Boston Garden area, as well as access into the North End and across the Washington Street Bridge to Charlestown City Square. There is no access to the Expressways northbound; access in the northbound direction must take place at Leverett Circle, North Street or in Charlestown.

Haymarket Square is served by one off-ramp in the southbound direction. This ramps serves the Government Center/West End/North Station area from the North. Return trips must use either the North Street ramps or travel to Charlestown for access to the Expressway network.

II.B.7

Connections between Surface Streets via the Artery

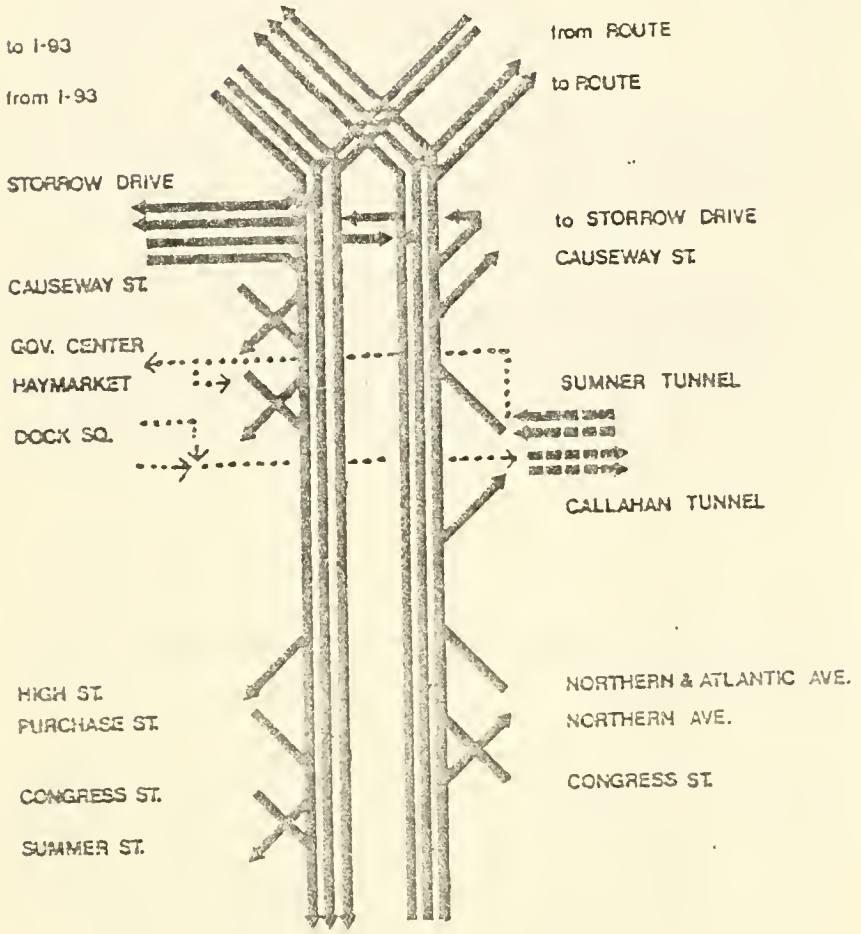
The Artery serves not only the functions already discussed, but often acts as a bypass for local traffic travelling between areas within Downtown. An example is the trip between North Station and South Station; direct local ramps serve both ends of the trip. The Artery is also used to bypass local streets when they become congested. The availability of ramps to numerous local streets makes the Artery a desirable facility for some of these trips.

II.B.8

Composite Artery Connections

The Connections provided by the Central Area all take place within the short Downtown section of the Artery. The multiple connections on this section of highway give rise to the traffic service problems of the Artery. (See Figure 14)

Figure 14 COMPOSITE ARTERY CONNECTIONS



II.C CENTRAL AREA TRAFFIC SERVICE PROBLEMS

The system characteristics of the Central Area of the Artery causes a series of traffic operations problems, resulting from the functions which this portion of the Artery is called on to serve. These problems result from a combination of functions which the Artery must serve and the inability of the facility to meet the demands placed upon it. These problems can be grouped into four basic categories: 1. Traffic volumes and conflicts; 2. Geometrics; 3. Service characteristics; 4. Safety.

Traffic volumes and conflicts

The Central portion of the Artery was constructed in 1954-9 to meet demand projections which estimated 77,000 vehicles per day. Today, the volume of traffic carried has grown to a level in excess of 135,000 vehicles per day. This volume of traffic is a direct product of the number of connections into the Artery from both Expressways and local streets. It represents the highest volume of traffic on any facility in the Commonwealth of Massachusetts.

Analysis of this traffic has been undertaken has been undertaken by the MDPW and CTPS, using base data collected by the Department of Public Works. The most recent available data -1975 - have been used in all traffic analyses, modified by new information collected in 1977 as part of the Southeast Expressway Downtown Express Bus Project. (Figure 15 shows the data in tabular form for a 24 hour period by direction and includes all on and off traffic and volumes between ramps. Figures 16 and 17 show the data by direction for a.m. and p.m. peak hours.)

For northbound traffic, the chief points of conflict are those associated with the exit to the harbor tunnels, the entrance from the tunnels and the surface at North Street and the exit to Storrow Drive/ Leverett Circle.

Southbound on the Artery, the principal points of conflict occur at the entrance from Storrow Drive/Leverett Circle, the exit ramp to North Street and the tunnels, the entrance ramp from the tunnels and the High Street ramp. The speed change lane between the entrance from Storrow/Leverett Circle and the entrance from the tunnels is a conflict area of substantial concern: between these two ramps there is an entrance ramp from Causeway Street and an exit ramp to North Street and the tunnels.

The volume of traffic carried on all of these ramps is so high that the movements cannot be accomodated smoothly and efficiently. The compounding feature of the operations of this portion of the Artery is, however, the geometrics of the present facility.

Figure 15:

Average Daily Traffic (ADT) on the Central Artery
Entering, Exiting and on the Facility

SOUTHBOUND ADT

At (location)	Entering	Exiting	On Artery	
Jct of Storrow Drive	--------	-------	53,550	CENTRAL AREA
Haymarket Exit	--------	2,550	51,000	
Causeway Entrance	6,600	-------	57,600	
North Street Exit	--------	14,700	42,900	
Haymarket-Cross Ent.	20,650	-------	63,550	
High Street Exit	--------	11,500	52,050	
Purchase Entrance	8,250	-------	61,300	
Dewey Square Exit	--------	5,850	54,450	
Congress Street Ent.	6,750	-------	61,200	
Beach Exit	--------	3,750	57,450	
Albany-Turnpike Eixt	--------	11,850	45,600	
Kneeland-Turnpike Ent.	17,850	-------	63,450	
Albany Exit	--------	5,250	58,200	
Albany Entrnace	13,000	-------	71,200	
Massachusetts Avenue Ent.	2,750	-------	73,950	
Massachusetts Avenue Exit	--------	7,600	66,350	
TOTALS	78,850	63,050		

NORTHBOUND ADT

At (location)	Entering	Exiting	On Artery	
South of:				CENTRAL AREA
Frontage Road Exit	--------	-------	60,050	
Frontage Road Entrance	--------	9,350	50,700	
Massachusetts Avenue Exit	--------	6,000	44,700	
Massachusetts Avenue Ent.	5,950	-------	50,650	
East Berkeley Street Ent.	8,600	-------	59,250	
Kneeland-Turnpike Exit	--------	18,500	40,750	
Turnpike-Broadway Ent.	20,450	-------	61,200	
South Station ent.	7,300	-------	68,500	
Northern-High Exit	--------	12,300	56,200	
Congress Street Ent.	10,350	-------	66,550	
Northern Avenue Ent.	7,850	-------	74,400	
Clinton Street Exit	--------	6,400	68,000	
Callahan Tunnel Exit	--------	15,950	52,050	
State Street Ent.	3,200	-------	55,250	
Tunnel Ramp Ent.	16,300	-------	71,550	
Causeway Street Exit	--------	9,350	62,200	
TOTALS	30,000	77,850		

Source: 1972 counts by Massachusetts Department of Public Works

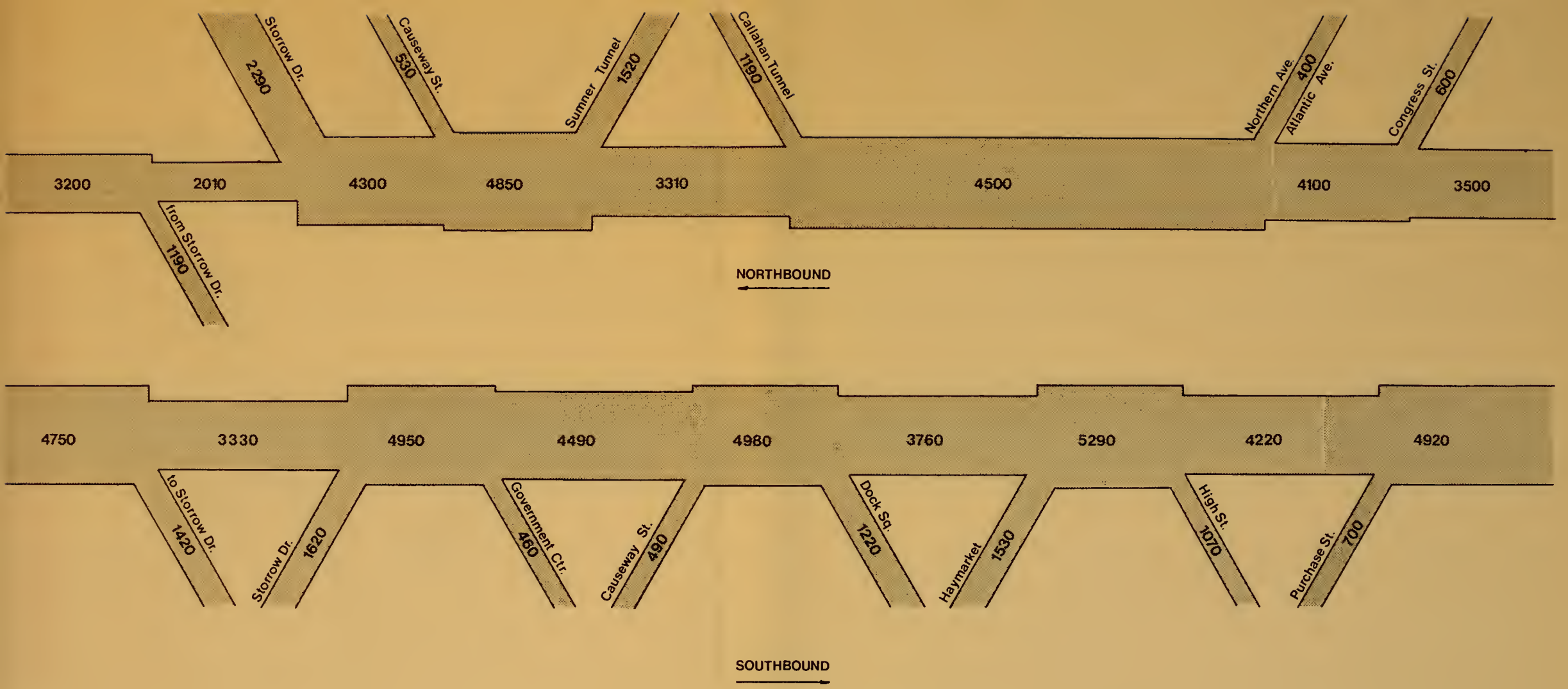


Figure 16

CENTRAL ARTERY
CENTRAL AREA

PEAK HOUR TRAFFIC VOLUMES
1975 A.M.

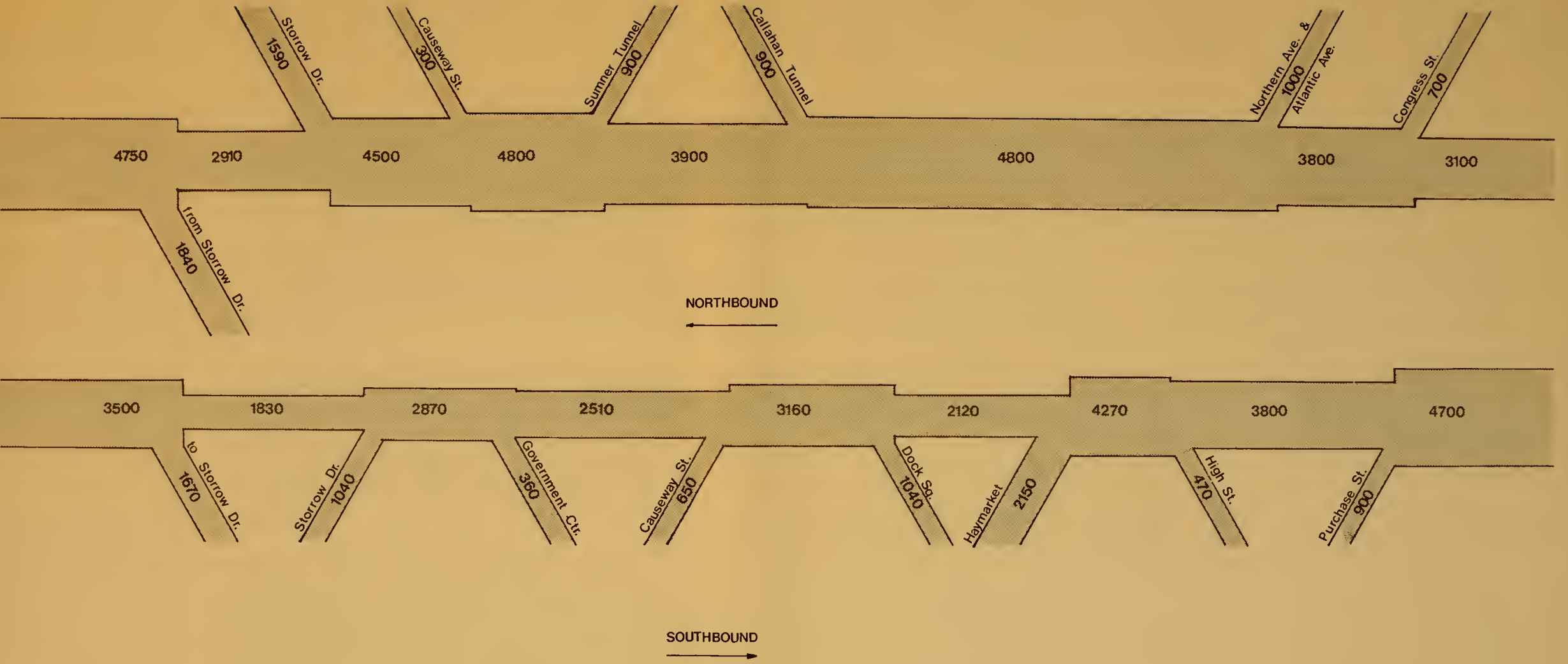


Figure 17

CENTRAL ARTERY
CENTRAL AREA

PEAK HOUR TRAFFIC VOLUMES
1975 P.M.

Geometrics of the Present Elevated Artery

The lack of interstate highway standards on the Central Artery is evident in the Central portion of the Corridor. In this area, the spacing between entrance and exit ramps, the lack of speed change lanes and breakdown lanes, and the substandard curvatures and sight lines on ramps and the main line of the Artery at Northern Avenue contribute to the problems of the Artery.

Ramp spacing in of particular consequence to traffic operations in this area. Figure 18 indicates diagrammatically the distances between the existing ramps. The shortest distances between ramps occur between the tunnels and the access to and from Leverett Circle. In both north- and southbound directions there is an entrance ramp to Causeway Street. In the southbound direction there is an additional ramp to Haymarket Square. All ramps are relatively short and cause traffic to back up onto the elevated Artery. The ramp to High Street near Northern Avenue is particularly difficult because of its curvatures.

The ramp system at North Street and the tunnel mouths is most deficient because it utilizes local surface streets. The configuration is such that traffic must use local streets to loop under the elevated Artery to make various directional moves to or from the Expressway. These moves are compounded by local parking and by traffic signals to accommodate large volumes of pedestrian traffic.

Weaving maneuvers are generally onesided, with areas of most serious weaves occurring in both north-and southbound directions between the tunnels and the Charles River Bridge. South of the tunnels, three ramps have been removed--the off-ramp to Clinton Street southbound, the on-ramp from Clinton Street southbound and the on ramp from State Street northbound. A related improvement restricts the northbound off-ramp to tunnel traffic only. A slip ramp, at the base of the Callahan Tunnel ramp, is under construction. This will allow oversize trucks not allowed in the tunnel to reach Clinton Street and the Waterfront area.

Overall, the Central Portion of the Artery is a six lane facility with each roadway consisting of three 12 foot lanes with two-foot lateral clearance on each side. There are neither shoulders or breakdown bays on the viaducts. Auxiliary speed change lanes do not exist between any of the ramps except for the section between the tunnels entrances and the Storrow/ Leverett Circle exit northbound and between the Causeway Street on-ramp and the North Street off-ramp southbound. The design speed on the Artery is 50 mph.

A speed change lane has been provided at the entrance of the Storrow-Leverett entrance ramp onto the southbound Artery, by taking one of the three lanes and by restricting the through facility to two moving lanes. Although designed for two-lane entrance; all ramps have been reduced to one lane through signing, pavement markings or physical restrictions.

Grades on the Central Portion of the Artery also pose operational and safety problems. The grade between the Central Area and the Dewey Square Tunnel is 4.4 per cent for approximately 800 feet. This reduces the capacity of the facility and introduces safety problems. The grades of most ramps are approximately 5 per cent, and in some instances are combined with curvatures which restrict capacity and produce unsafe operating conditions.

The alignment of the Central area was selected in order to avoid specific existing land uses and buildings and to meet local streets for collection and distribution functions. As a consequence the roadway has numerous curves and peculiarities in its horizontal alignment. The most serious curve is on the High Street ramp on the southbound roadway.

II.C.3

Service Level Consequences

The combined influence of the traffic volumes and geometrics of the Central Area have serious consequences. Service overall is reduced throughout the day, and at peak hours the situation becomes critical. The analysis of the present levels of service

indicates a level of service (LOS) of E during most off-peak hours, and F during peak hours. This analysis was derived as follows:

Theoretical capacity of each roadway of the main line of the Central Areas of the Artery has been determined to be 5530 vehicles per hour (VPH). Methodology used to determine capacity was that recommended in the Highway Capacity Manual. In general, capacity is defined as "the maximum number of vehicles which has a reasonable expectation of passing over a given section of a lane or roadway in one direction during a specific period under prevailing roadway and traffic conditions." Under these theoretical volume conditions traffic flow on the facility is unstable, involving overall operating speeds in the neighborhood of 30-35 MPH with momentary stoppage of traffic. Traffic flow within the hour will exhibit relatively little fluctuation. This condition on a highway is also defined as " Level of Service E."

The above discussion relates to a continuous section of a main line of a highway. In addition, investigation of specific locations at critical areas of a highway is necessary to identify bottlenecks or spots where capacity is reduced. Of particular importance on the Central Section is the grade of the northbound roadway. At the extremes of both tunnel portals, the grade of the highway is approximately 5 per cent. This has the effect of reducing theoretical capacity on the facility from 5530 vph to 4260 vph. Volumes on the northbound roadway in excess of 4260 vph result in service deterioration from the previously noted Level of Service "E"--to a condition known as Level of Service "F"--forced flow, operation at low speeds (0-25 mph); here the highway acts as a storage area with many stoppages.

Volumes between ramps in both the A.M. and P.M. peak periods approach or exceed theoretical capacity. This overloading of the main highway portion of the Central Area is further compounded by entering and exiting ramp traffic. During peak hours this results in vehicles entering the main stream of traffic without the value of acceleration lanes. Conflicts result on both the main line and at ramps as queued ramp vehicles attempt multiple entry, thereby compounding the conflicts. In most

cases, vehicles exiting from the Artery must weave across entering vehicles due to the sub-standard spacing of ramps.

All these factors in combination, together with inadequate capacity to accommodate demand, result in the Artery operating under forced flow, Level of Service "F", during both A.M. and P.M. peaks. Operating speeds in peak hours are between 0 and 27 mph, as measured during the Southeast Expressway Downtown Express Lane Project, April 1977.

During the A.M. peak period, operations on the Central Artery are forced flow, constant demand, interrupted traffic operations (stop-start), queues of up to 1.5 miles, and average running speed of 12 miles per hour. This illustrates a classic definition for level of service "F".

II.C.4

Delays and Queues

Queuing on the expressway causes dispersion of expressway traffic onto local streets that are at or near capacity. This causes a substantial deterioration of service levels on local streets in the Central Artery corridor. Because of the above cited conditions in the Central Section, traffic from the Sumner Tunnel interchange is queued on both roadways during the A.M. peak. Similarly, in the evening peaks, traffic causes extreme congestion at the Storrow/Leverett Circle ramps and the Callahan Tunnel interchange.

II.C.5

Accidents

A review has been made of accident data ocurring on the Central Section of the Artery between the area just north of the Dewey Square Tunnel and the Storrow Drive/Central Artery ramp system. Both the north and southbound roadways and the associated exit and entrance ramps have been analyzed. For consistency with both the North and South Corridor Planning Studies, 1975 accident data is used in this report.

The Accident Records System of the Department of Public Works was used to identify "reportable accidents." That is, the only accidents included in this report are those involving property damage only (PDO) in excess of $200, an injury, or a fatality. Figure 19 presents 1975 accident data for the Central Area.

Figure 19: Central Area Expressway 1975 Accident Data

Total Accidents	262
Property Damage Only (PDO)	181
Injury Accidents	81
Injuries	117
Multiple Vehicle Accidents	220
Total Vehicles Involved	542

From Figure 19, the following comments can be made: 69 per cent of the accidents are PDO accidents; 84 per cent were multiple vehicle accidents; and 31 per cent of the accidents resulted in injuries.

In addition to accidents occurring on the Central Artery and its ramp systems, accidents have been identified on the surface streets adjacent to the Artery in the Central Section. Figure 20 presents these accidents.

Figure 20: Surface Streets in Central Section of the Central Artery--1975 Accident Data

Total Accidents	269
Property Damage Only (PDO)	208
Injury Accidents	61
Injuries	77

Accidents are 2.6 times the national average for comparable facilities, and injuries are 1.3 times. Experience throughout the country has shown that only 20 to 40 per cent of property damage only accidents are normally reported to public authorities. Many researchers suggest that to compensate for this under-reporting, PDO accidents should be adjusted.

In the absence of more precise information on the degree of under-reporting, multiplying the reported accidents by a factor of 2.5 (assuming a 40 per cent reporting level) would yield a total of 1470 accidents for the Central Section and contiguous surface streets (1328 PDO + 142 Injury). Analysis of accident data for the Central Section of the Artery clearly has demonstrated that a high hazard potential for accidents does exist.

II.D ENVIRONMENTAL CONDITIONS

II.D.1

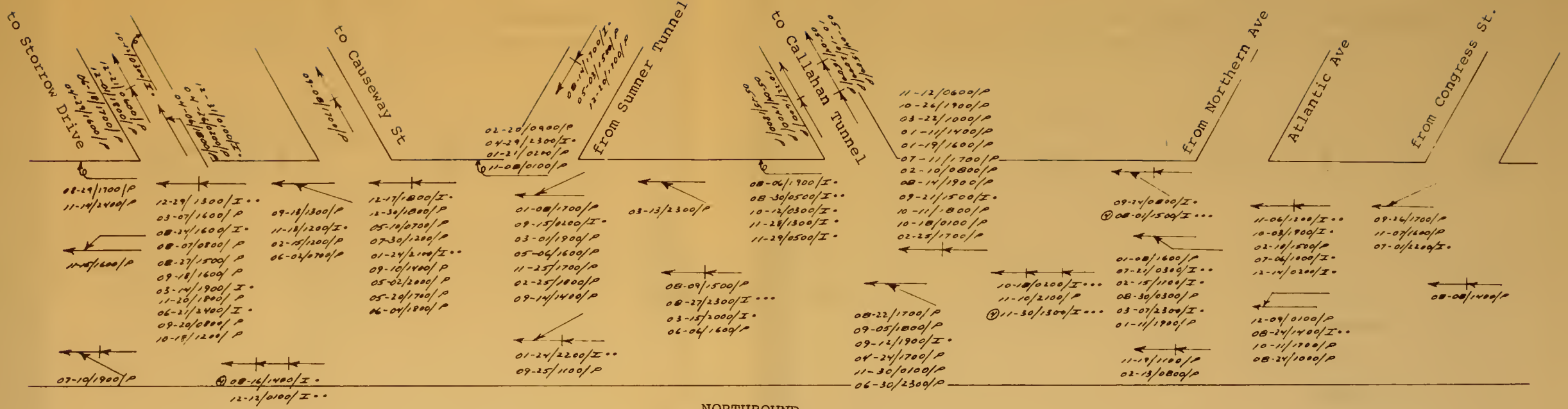
Existing Air Quality

The most important source of existing carbon monoxide, hydrocarbons and oxides of nitrogens in the Central Area is the dense traffic that flows at all hours on the major downtown streets, on the elevated Central Artery itself, and especially in the vicinity of the Sumner and Callahan Tunnels. This traffic travels at slow speeds in stop-and-go conditions for a large portion of the day, contributing huge quantities of CO and hydrocarbons to the surrounding areas.

Calculations of 1975 gross pollutant emissions for CO, HC and NO_x were carried out for the Central Section main line and ramps. Emissions factors used for this analysis were average emissions factors for 1975 from EPA's Compilation document, Supplement 5 (1975). The emissions factors were speed-corrected to correspond to measured speeds on individual links. Total vehicle-miles of travel were calculated for the Central Section main line and ramps only (i.e., not including local streets and arterials), using 1975 traffic volumes; these were used to produce pollutant burden estimates, in tons per year of pollutants emitted. Trucks were assumed to be 3 percent of the vehicle population. The resulting estimates are presented in Figure 23 below.

Figure 23: 1975 Gross Pollutant Emissions--Central Artery--Central Section, with Ramps

Pollutant	Emissions, tons/yr.
CO	5220
HC	570
NO_x	430



LEGEND

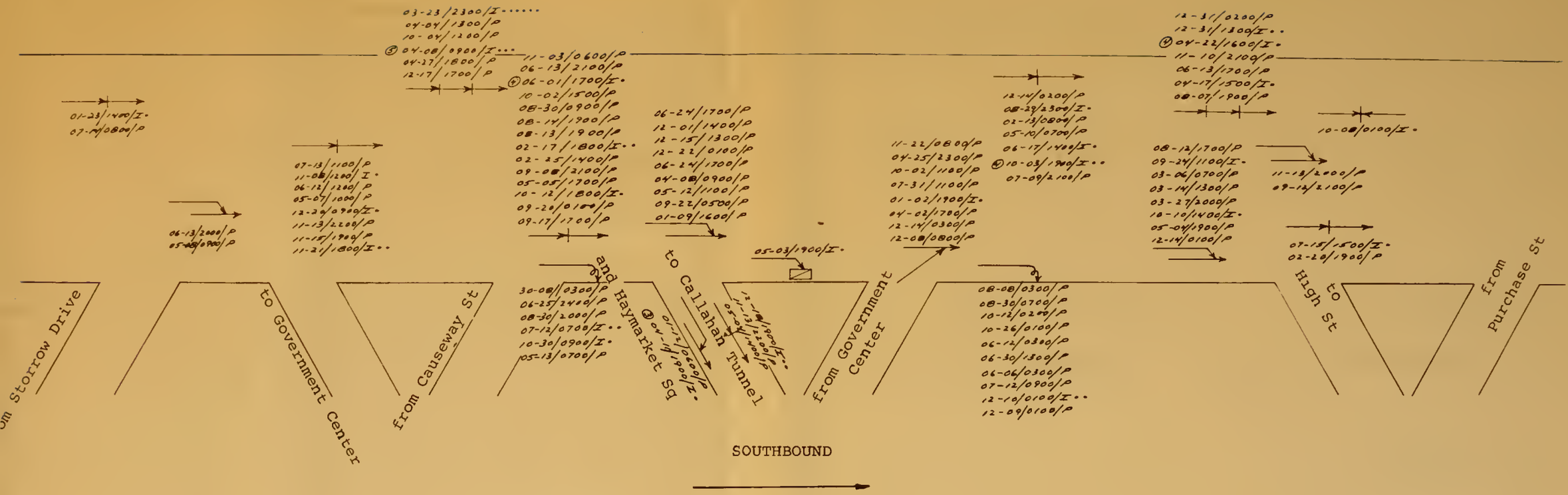
←K	Rear End
←<	Angle
←|	Lost Control or Ran Off Road &/or Hit Fixed Object
•	Injury
*	Fatality
▨	Parked or Stalled Vehicle
O	Pedestrian
④	No of Vehicles (if more than 3)
03/11	March 11, 1975
1700 (hrs)	5:00 p m
P	Property Damage
I	Injury

Note: Of the 262 identified accidents in the Central Section of the Central Artery (I-93), 213 have been plotted (115 Northbound, 98 Southbound). There is insufficient data to plot the remaining 49 accidents, (i.e. date, specific location, type of accident, etc.)

Figure 21

CENTRAL ARTERY CENTRAL AREA

COLLISION DIAGRAM: NORTH BOUND



LEGEND

←K	Rear End
←	Angle
↓	Lost Control or Ran Off Road &/or Hit Fixed Object
•	Injury
*	Fatality
▨	Parked or Stalled Vehicle
O	Pedestrian
④	No of Vehicles (if more than 3)
03/11	March 11, 1975
1700 (hrs)	5:00 p.m.
P	Property Damage
I	Injury

Note: Of the 262 identified accidents in the Central Section of the Central Artery (I-93), 213 have been plotted (115 Northbound, 98 Southbound). There is insufficient data to plot the remaining 49 accidents, (i.e. date, specific location, type of accident, etc.)

Figure 22

CENTRAL ARTERY CENTRAL AREA

COLLISION DIAGRAM: SOUTH BOUND

Existing Noise Climate

The noise climate along the Central Section, as along the entire length of the Central Artery, is created primarily by the dense city traffic which traverses the area--on the Artery itself, on the major streets in its vicinity (including Sudbury and New Chardon, Washington, Commercial, Hanover, State, High, etc.--most of the busiest streets in the downtown area), and entering and leaving the Sumner and Callahan Tunnels. Traffic levels on all these sources tend to be high at almost all hours of the day and night, creating the extremely high noise levels characteristic of dense urban centers.

The Artery itself constitutes a major noise source, but not necessarily the major noise contribution in the area. This was demonstrated in the South Area studies, where a noise measurement program conducted in 1972 revealed little difference in L10 noise levels between areas traversed by an exposed section of the Artery, and areas where the Artery was completed enclosed in the Dewey Square Tunnel.* In a congested downtown area such as the present study area, the addition or subtraction of a single noise source, similar in magnitude to preexisting noise levels from numerous sources, causes very little change, for good or bad, in the resulting overall noise climate. The implication of this fact is that no major change in the noise climate areawide is likely to result from the present plans for the Central Section. Some specific areas--particular rows of buildings, particular streets--may, however, experience changes in the noise levels they are exposed to as a result of the design changes proposed.

Noise measurements were made within the present study area in Septmenber 1974 as part of the BRA Central Artery study. Three statistical measures of the noise climate during the sample period, all in A-weighted decibels (dBA), are given in Figure 23. The locations where monitoring stations were established and the noise levels which resulted are reported in Figure 24.

---

*"Noise Analysis Technical Support Document to the Environmental Impact Report--South Station Urban Renewal Project," prepared by Environmental Research & Technology, Inc., May 1976.

Figure 23: Noise Measurement Levels

(1) L10, the noise level exceeded 10 percent of the time during the sample period. This is one of the statistics in which the Federal Highway Administration's Design Noise levels are expressed.

(2) L50, the median noise level, exceeded 50 percent of the time during the sample period.

(3) L90, the level exceeded 90 percent of the time; represents an approximation of the "noise floor."

The data indicates that noise levels at different locations within the study area tend to vary depending on the distance from a major source, the amount of shielding available to a particular location, and the time of day at which the measurement was made. At all locations but one, however, the range from L10 to L90 is fairly small--10 dBA or less, suggesting that high noise levels are a constant, rather than intermittent, phenomenon throughout the area. The single exception is the Haverhill-Causeway St. site, where noise associated with elevated Green Line and Orange Line rapid transit operations was the probable source of the high L10 level recorded. (NOTE: the Orange Line has been relocated underground since the completion of the noise survey reported.)

At most of these sites, the measured L10 level exceeds 70 dBA, the Federal Highway Design Noise level for residential land use; at 4 sites, L10 exceeds 75 dBA, the Design Noise level for commercial, industrial and other relatively noise-insensitive uses. Harbor Towers was, at the time of the survey, the closest occupied residential area directly abutting the Artery; the noise levels reported at location 1 (see Fig. 24) are extremely high. The recent redevelopment of much of the waterfront area has created additional areas of noise sensitivity directly abutting the Artery. These locations--the waterfront park, the Quincy Market development, the renovated Mercantile Building and the newly rehabilitated Fulton and Commercial Street residential properties--are or will be subjected to noise levels similar to those presented in Figure 24.

Figure 24: Noise Measurement Results
Central Artery (Central Section) - 1974

Location	Description	Time of Day	Noise Level, dBA		
			L10	L50	L90
1	Harbor Towers Apts.--Apt. 7B	8:30 AM	77	74	71
2	State St. & Atlantic Ave.	4:50 AM	74	67	65
3	State St., across from 189 State	7:50 AM	79	74	73
4	Near entrance to Callahan Tunnel*	4:50 PM	64	61	60
5	Haymarket--Blackstone St.	6:50 AM	72	68	64
6	Hanover St. near VFW Post between Richmond & Expressway	4:30 PM	68	62	58
7	Parking lot under expressway --Haymarket	4:00 PM	74	69	67
8	Steps of Gov't. Center	3:50 PM	69	65	62
9	Cooper & Endicott St.	3:30 PM	67	62	58
10	Causeway St. underneath Expway.	5:30 PM	79	75	73
11	Haverhill & Causeway	7:00 PM	90	73	69

*stop-and-go, crawling traffic

Source: Memo from K. Kleinschmidt, Cambridge Acoustical Associates, to David Wallace, Wallace, Floyd, Ellenzweig, Moore, Inc., re Central Artery Noise Survey, April 26, 1977.

54

CHAPTER III ALTERNATIVES FOR IMPROVEMENT

Past and current studies are summarized below in two groups--alternatives outside the present Artery Corridor, and alternatives within the present Corridor.

III.A ALTERNATIVES OUTSIDE THE ARTERY CORRIDOR

There have been several concepts for bypassing the Artery in order to avoid the difficult problems of serving both local and through traffic on the same facility. These have been dropped from further consideration for various reasons. The alternatives are as follows: (See Figure 25)

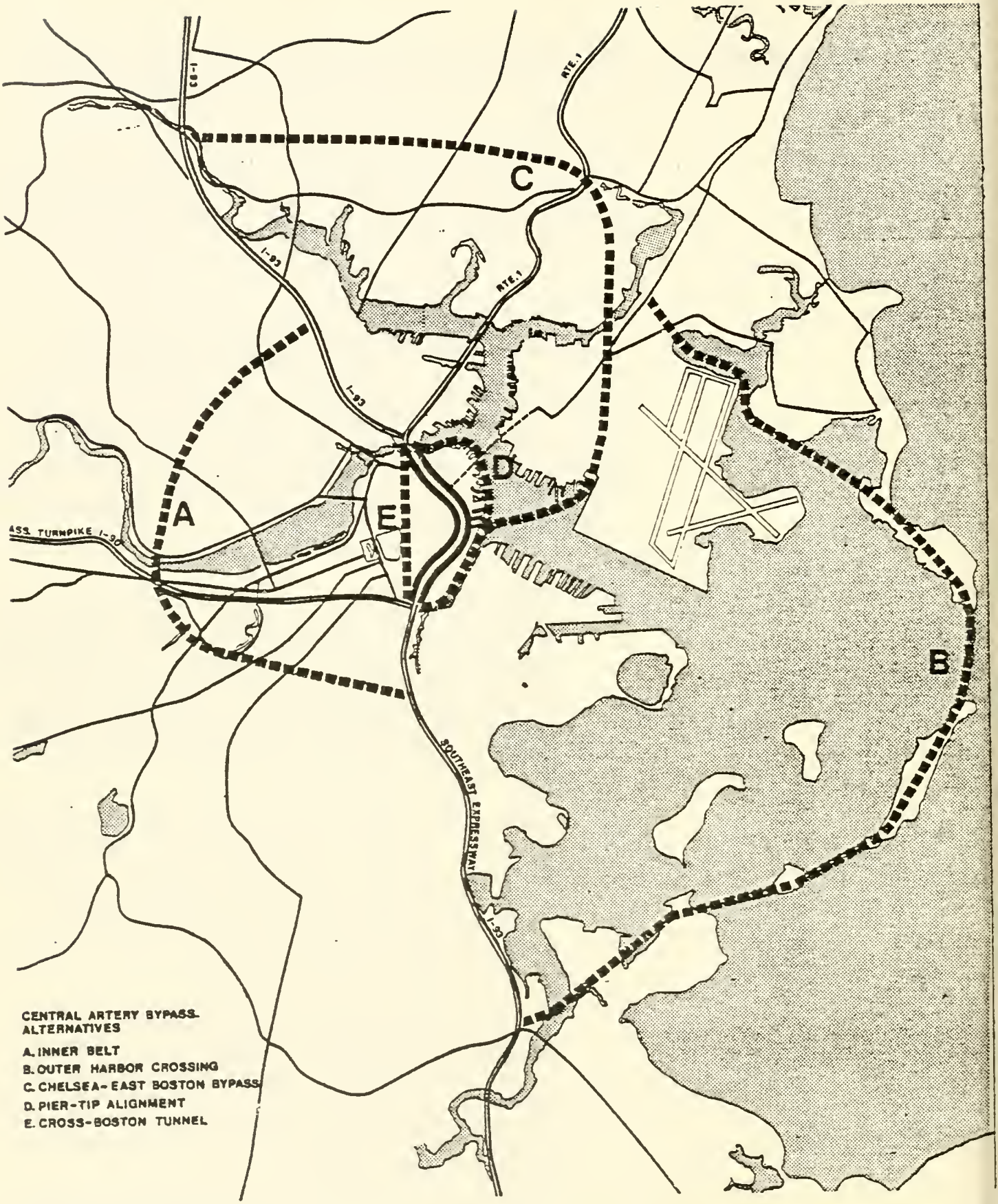
A. The Inner Belt

The philosophy of a radial expressway and inner belt highway system was presented in the Master Plan for Highways in the Boston Metropolitan Area in 1948, and was adopted by the Commonwealth as a basis for long-range improvement to area highways. The Central Artery was a portion of the Inner Belt under this plan.

The basic functions of the Inner Belt were: (a) to serve as a collector-distributor of traffic in the Core Area and (b) to interconnect radial expressways for traffic with an origin or destination either in metropolitan Boston or on any part of the interstate highway system.

As a partial result of this plan, the Central Artery was constructed. To complete the Belt, a series of 30 alternatives was studied and 10 were examined in detail. However, in 1971, Governor Sargent made the decision not to proceed with further plans for the Inner Belt, for these major reasons:

1. Extensive residential takings in Somerville and Cambridge and inability to meet the relocation requirements, which had become more stringent since initial plans were put forth.



ALTERNATIVES TO THE ARTERY CORRIDOR

Figure 2:5

2. Major disruption to communities along the corridor of the proposed highway, to which local municipal officials had become opposed.

3. Community protest over the scale, location, impacts and costs of the proposed Inner Belt.

4. Technical questions resulting from re-examination of the traffic projections and the ability of connecting radials, including the Central Artery, to accommodate projected volumes and movements.

5. Increased highway construction was considered to be counterproductive because it would generate traffic for the core area of Boston, which cannot accommodate present traffic and parking demands.

Since the Governor's decision, funds previously allocated to the Inner Belt have become part of the Massachusetts Interstate Transfer. In addition, the Commonwealth's transportation policy and decisions about specific facilities have reinforced the determination that the Inner Belt is no longer a feasible, desirable or prudent alternative, nor is it politically acceptable.

B. Outer Harbor Crossing
As early as the 1930's, a highway to connect between Route 1-A on the north and the area south of the core was examined.

This was later reviewed and studied by the Boston Transportation Planning Review as a connection between Route 1-A and the Southeast Expressway. The proposed facility used the harbor island for its route, in a combination of bridges and surface facilities. A major crossing of the shipping channel leading to and from Boston Harbor was included. While the alternative of a tunnel was suggested for this crossing, problems of interference with the shipping channel along with anticipated costs of construction precluded it from further consideration. The proposed bridge was similarly difficult; under-clearance requirements for shipping made the bridge a hazard for Logan Airport flight path clearance standards. In addition the

proposed approach roads would have violated Section 4(f) provisions in utilizing islands, wetlands and publicly owned land along the proposed alignment.

While this alternative would have provided connections for two major expressways and a bypass for the Central Artery, it did not provide connections and distribution to the various sections of the region, and it did not provide adequately for downtown collection and distribution. Access to the Airport was also constrained by the need for interchange of traffic in either the residential or open space areas of East Boston. While it may well have resulted in new origins and destinations it did not address the problem of the existing traffic overloads on the Central Artery, as very little traffic would have been diverted from the Artery.

C. Chelsea--East Boston Bypass

Another alternative investigated in 1971 was a downtown bypass from I-93 on the north, through Chelsea to East Boston and the Airport and in a tunnel under the harbor, to connect to the Southeast Expressway--Mass. Pike interchange at the south edge of downtown. This alternative was conceived as part of plans then being considered for I-95 north through Lynn, and I-95 relocated through East Boston and Revere. It was intended to address the problem of how traffic on the north from both I-93 and proposed I-95 could get access to the Airport and around Downtown for non-core destinations. The bypass was also directly related to a proposed general purpose Third Harbor Crossing between East Boston and the Fort Point Channel area in South Boston, and in fact incorporated this tunnel as a major element of its alignment.

Early analysis of this alternative showed that the proposed alignment had a number of major problems of feasibility. The proposal would have required either a new alignment or a narrow rail right-of-way in the Everett/Chelsea area which would have caused substantial residential property takings and impacts on local neighborhoods. The Chelsea Creek crossing was complicated by the need to retain shipping access to the oil terminals located at the head of

the Creek. In East Boston, major conflicts with expressway and local circulation, along with substantial impacts on the adjacent residential community were also found. The location through either East Boston or the Airport was another major problem. This was later resolved by a decision to use Airport property for connections to the proposed Third Harbor Crossing. Because of impacts of this alignment, longer tunnels were discussed, but the costs and potential impacts were prohibitive. In addition, because of the lack of direct connection to I-93, the over-capacity conditions on the Central Artery would have remained.

After preliminary analysis and strong community objections to the alignment, this proposal was dropped. Its dependence on I-95 through Lynn, and relocated I-95 through East Boston and Revere became apparent, and both of these alternatives were dropped from further consideration by the Commonwealth. The Third Harbor Crossing portion of the alignment remained as a viable portion of the proposed connection--not as a bypass of the Central Artery, but for service directly to and from the Airport.

D. Pier-Tip Bypass

After analysis of alternatives outside the main core area of Boston, other alignments closer to Downtown were investigated. A pier-tip bypass was proposed, connecting between the junction of the Mystic Bridge and I-93 on the north and the junction of the Mass. Pike and the Southeast Expressway on the south, and using the harbor bottom as the right-of-way along the ends of the downtown piers. The alternative's advantages were: (a) construction of a new facility without disturbing traffic in the heart of the city; (b) a right-of-way which would be "free" and which would afford relative ease of construction; (c) the potential for separation of local and through traffic with the existing Artery retained for the collection and distribution of traffic in Downtown Boston.

However, this alternative did not address the problem of providing improved access between major expressways and the Airport because it could not connect directly with

the existing tunnels and the proposed Third Harbor Crossing. This became a major deficiency, because the pier-tip tunnel would only serve north-south through traffic and not meet major demands for access between expressways and either the Airport or Downtown. Problems with the physical feasibility included grades of the connections on either end, possible interference with shipping in the harbor during construction, plus the logistical problems of constructing a long tunnel entirely under water, with attendant difficulties of getting approvals for the filling required to construct the tunnel.

Because of its prohibitive costs and environmental impacts, it was decided that the alternative was not feasible, and it was dropped from further study.

E. Cross-Boston Tunnel

The last of the alternatives that would bypass the corridor of the existing Central Artery was a proposal advanced in 1974 for construction of a deep-bore tunnel to connect directly from the Mystic Bridge I-93 intersection on the north to the Southeast Expressway and Mass. Pike interchange on the south. The elements of this proposal included an additional short tunnel connecting the north to the entrance of the Sumner/Callahan Tunnels on an alignment directly under the existing Artery to serve airport traffic. It was proposed that, following construction, the Artery could be removed and the corridor used as a major arterial street providing access to Downtown locations.

The advantages cited included: (a) the length of the tunnel, which would be the shortest possible connection between major regional expressways; (b) construction would not be entirely in the Artery corridor (other alternatives being considered at the time used the existing Artery corridor for a new facility); (c) preliminary examination indicated that overall construction impacts would be significant, but less than other alternatives.

The proposal had several major drawbacks: (a) its common weakness shared with other past proposals was its inability to deal with the role of the Central Artery as a

downtown collector and distributor of traffic, though it did have the advantage of exclusive access to the Sumner/Callahan Tunnels; (b) the proposed arterial street could not adequately meet existing collection and distribution demands in the Downtown area. It would have produced spill-over traffic on local streets, with impacts on adjacent residential and business areas; (c) there are serious questions of feasibility that a highway rising from a deep-bore tunnel across Downtown Boston could meet the necessary vertical clearance requirements to cross the Charles River without constructing a massive, multi-tiered interchange in the North Station area; (d) sub-surface conditions in the area of the proposed tunnel may be such that this alternative is technically infeasible. Construction problems near and under large buildings, utilities and subway tunnels were major; (e) the proposed tunnel would have required installation of extensive ventilation equipment to meet present and future air quality standards. The location of ventilation structures and the impact of the exhaust disposed through ventilation structures would have produced major negative impacts on Downtown. For all of these reasons, this alternative was dropped from further study.

III.A.1

Corridor Retention

The analysis of alternatives to bypass the corridor of the present Central Artery has been instructive on several points:

1. Alternative alignments for the relocation of all or part of the present functions of the Artery cannot be easily found. Alternatives which have been presented and examined in some detail have the disadvantages of not replacing or relocating the functions of the Artery and not substantially easing its present problems.

2. High costs are incurred in all of the alternatives to the present Artery corridor, both in terms of funding the construction and operations on adjacent neighborhoods.

3. The present Artery would have to be retained in virtually all instances as a collection and distribution facility for Downtown, and in most instances for Airport access via the Sumner/Callahan Tunnels as well.

4. Improvements to the present facility would be required in all alternatives. Safety considerations and the aging structure of the present facility must be dealt with at some future date. Simply eliminating the present Artery without adequately providing for its present functions is not a solution to transportation needs.

5. All of the alternatives to the present Artery tried to find means of avoiding the problems associated with construction of a new facility in the present Artery Corridor while maintaining traffic. However, the present corridor of the Central Artery is the only alignment which affords all the advantages of connections between the radial regional expressway network. In addition, it is the only alignment which provides collection and distribution into the regionally important downtown area. It thus appears that the present Artery corridor must be retained for these functions.

III.B ALTERNATIVES WITHIN THE PRESENT CORRIDOR

The Central portion of the Artery Corridor contains highly valued land areas and neighborhoods which form major constraints to the selection of alternatives for transportation improvements. Efforts which have taken place or which are planned for the future must be considered as the setting for further examination of Artery and related transportation plans.

III.B.1 Central Area Highway Planning Context

Each of the efforts listed below is identified on Figure 26 by the numerical designation which appears in the text.

1. Commuter Rail Improvements: The MBTA expects a substantial increase in rail commuter usage in the 1980's. Improvements to be made to the system include: purchase of the B&M tracks and yards; upgrading of railbed and equipment; improvements at North Station.

2. Massachusetts Rehabilitation Hospital: This large building (283 beds) is located immediately adjacent to the River and the rail platforms of North Station. There are no present plans to expand the hospital significantly.

3. Public Works and Registry Building (100 Nashua Street): Relocation plans for the Massachusetts Department of Public Works main headquarters are to relocate the MDPW to the new state Department of Transportation building in the Park Plaza area.

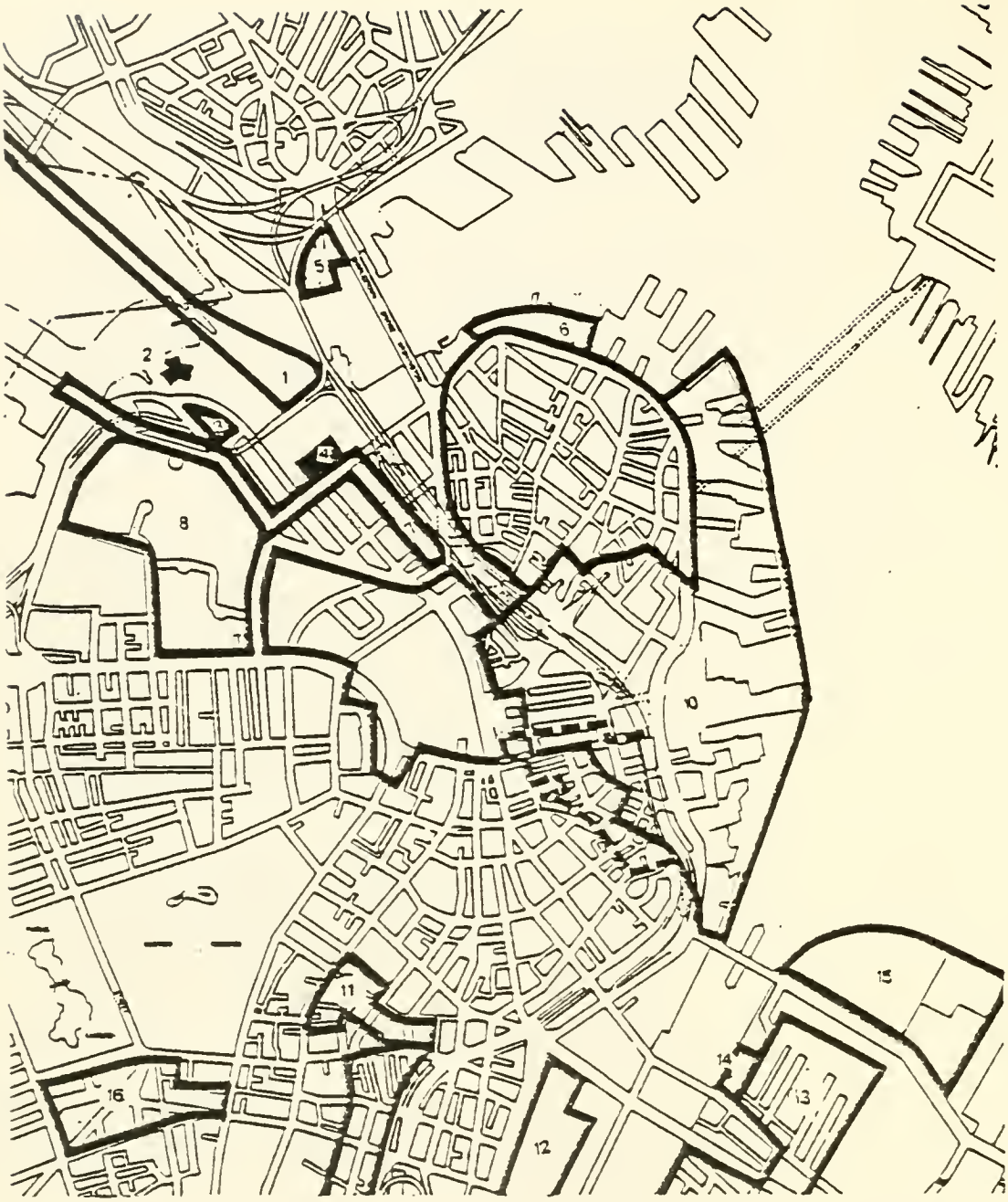
4. North Station: This large building is currently undergoing rehabilitation by its new owners, with $9 million in interior renovations, and related improvements in the concourse areas shared with the North Station commuter rail facilities. Plans have been developed to rebuild the rail facilities closer to the concourse area, to shorten the walk between the station, the train platforms, and the rapid transit stations on Causeway Street.

5. Paul Revere Landing Park and Charles River Dam: The new Charles River Dam and locks are nearly completed, with a small triangular parcel in Charlestown developed as a park to commemorate Paul Revere's landing on this site to begin his famous ride.

6. North End Park: Jointly managed by the city and MDC, the North End Park has been expanded by five acres, including a new ice rink.

7. Green Line Relocation: Relocation of the Green Line between Haymarket Station and the river crossing to Lechmere has been discussed to replace the existing el on Causeway Street with a new facility, possibly underground. This improvement could be constructed in conjunction with Artery improvements to the Leverett Circle area.

8. West End Urban Renewal Project
This Project is virtually completed, except for the upgrading of Martha Way (Merrimac Street) between Leverett Circle and Causeway Street; and one large renewal site at the intersection of Merrimac and Causeway Streets.



RELATED PLANNING EFFORTS

Figure 26

9. Government Center
This project is now largely completed. In addition to city, state and federal office buildings, it includes a large parking garage.

10. Waterfront Urban Renewal Project
This project includes expanded and new uses along the Commercial Street--Atlantic Avenue area at the edge of the harbor, and in the Haymarket area adjacent to the Artery-tunnel interchange.

11. Lafayette Place
This area has been designated for new commercial development and a major new parking facility.

12. South Station Transportation Center
Major plans have been developed to construct a rail station for intercity rail, commuter lines and parking.

13. Town and City Properties, Ltd.
Many of the existing large warehouse structures are planned for rehabilitation for new commercial uses.

14. Museum Wharf
The new home of the Children's Museum and the Museum of Transportation is a former wharf building, to be rehabilitated and partially opened in 1978.

15. The Fan Pier--Athanas Properties
A large-scale private development is planned to include apartment and marina activities.

16. Park Plaza
Recent City efforts have led to a plan for a multiple use area which will include retail activities, government and private offices and apartment units.

17. Broad Street National Historic District
This district includes the old Customs House and many other historic commercial structures which will be renovated for new uses, including business and residences.

III.B.2

Derivation of Alternatives

Land uses and proposed community improvements were examined in conjunction with transportation problems in the Central Area. Constraints imposed by the need to plan improvements within the existing orridor and to minimize impacts on surrounding areas led to two classes of alternatives. The first group provides for improvement along the present alignment. This includes the no-build option, widening of the present, viaduct, and double-decking. In all cases, traffic in both directions would continue to use the present alignment with proposed modifications.

The second class of alternatives is reconstruction of the Central Artery in a tunnel. With the Artery in a tunnel, there could be a transit way in the median. In order to narrow alternatives, each of these groups was analyzed in some detail.

III.B.2.a

Improvements along the Present Alignment

This set of improvement options centers on the existing viaduct in the Central Area.

1. No Build - In this option, the existing facility is retained and modified as necessary to accommodate minor improvements for traffic service and safety. Traffic capacity and design standards would remain the same as they now are. Deck rebuilding would be required throughout the viaduct.

2. Widening of the Artery for Full Length - Several possibilities exist for widening and range from modest improvements to breakdown and speed change lanes to the addition of new lanes for carrying traffic. If new lanes are added, they must be located on the existing vaiduct on one or both sides, with traffic reallocated between existing and new sections.

3. Double Decking of the Present Facility - This option would create an additional level of highway on a viaduct over the present Artery. Capacity would be increased and traffic would be reallocated onto the new lanes on the top level for through movements.

Each of these options for improvements along the present alignment has been examined for feasibility and adaptability to the Artery setting. The No Build option must be carried forward, not only because it may in fact be a reasonable solution, but also because it provides the base case for analysis of other options. Widening can also be retained, as a possible cost saving approach to solving certain of the present Central Area problems. However, preliminary analysis indicates that impacts from widening the present facility for its full length are severe for adjacent communities and would be unacceptable to them. Existing structures come within 10-15 feet of the existing structure, so that widening would involve major takings and additional impacts on structures not taken-particularly Quincy Market and Broad Street Histiric District. Selective widening of modest proportions can be examined for specific locations where operational problems can be solved by adding speed change lanes or breakdown bays. Such improvements would be part of the No Build Alternative.

Double decking would be unacceptable to the communities nearby and would extend the blighting influence of the existing viaduct into adjacent areas. Double decking would severely impact the adjacent buildings and would result in difficult design and engineering problems of connecting the upper roadway to other facilities (local street connections are virtually impossible to provide without extensive land damages.) The crossing of the River would be complicated by a required new birdge on several levels. The design of links between the new upper deck and the existing facilities would also be difficult to achieve withough substantial environmental impacts and would disrupt traffic during the construction period.

III.B.2.b

Reconstruction Alternatives

This set of improvements possibilities center on the use of tunnels carrying one or both directional movements to relieve the problems of the present viaduct. The new tunnels would be located in the present right-of-way of the Artery.

1. Tunneling for one-directional movement
This option includes a new northbound tunnel which would be constructed between the Artery and the Harbor tunnels. It would connect with the South Area of the Artery in the vicinity of the Dewey Square Tunnel and would follow the existing right-of-way to the harbor tunnels. A southbound tunnel between Storrow Drive and the harbor tunnels could also be build under the Artery. These alternatives would remove some of the traffic now on the viaduct.

2. Tunneling for Two-Dirctional Movement
This option is a new tunnel for the Artery through Downtown. It includes the possibility of a transit way in the median, and a full, grade-separated interchange with the harbor tunnnels/ underground. It required two-new bridges over the Charles River, with underground interchange facilities to Storrow Drive.

Of these two options, tunneling for one-directional movements produces significant disruption costs while existing structure permantly. It requires difficult designs to fully interconnect the facilities, but retains the need for replacing the decks on the viaduct It would however, be possible to use the technique as part of the staging for a larger tunneling scheme.

Tunneling for all Artery traffic affords the possibility of resolving the transportation problems of the Artery, while adding a transit way for new service. It is the only option which removes the environmental

impacts caused by the elevated facility and which allows substantial environmental and development opportunities.

III.B.3

Alternatives for Further Study

The remaining options have been extensively examined in conjunction with other possible projects in or connecting to the Corridor. In all instances, it has been assumed that the North Area Project will be undertaken; without it, the proposed alternatives for the Central Area cannot be undertaken.

III.B.4

Relationship to Other Potential Projects

The remaining possible projects which seriously influence decisions in the Central Area of the Artery Corridor are:

1. The proposed improvements in the South Area of the Artery Corridor.

2. The proposed Third Harbor Tunnel between Downtown and Logan Airport; if constructed this project would connect only to Logan Airport. It has two possible forms of service:
   a. A special-purpose tunnel, serving only buses, trucks, taxis and emergency vehicles to and from the Airport.
   b. A general-purpose tunnel serving all types of vehicles to and from the Airport.

3. The proposed transit way between North Station and South Station. This proposal is included as an integral part of all alternatives for reconstruction of the Central Area of the Artery Corridor.

III.B.5

Separability of the Central Area

Proposed improvements in the Central Area can take place in conjunction with other improvements. In all no-build alternatives, the improvements can be made without any other projects. In all reconstruction alternatives, the proposed North Area improvements in the corridor must be

made--either in conjunction with Central Area improvements or prior to the proposed reconstruction. This is because reconstruction includes major rebuilding of the Charles River Artery crossing; North Area expressway links could not be made from existing structures without extensive rebuilding.

Related projects for a Third Harbor Tunnel could also be made without or without a reconstruction of the Central Area of the Corridor. The relationship of other potential projects is nonetheless important. For purposes of analysis, the relationship of the Central Area fo the South Area and the Third Harbor Tunnel has produced the permutations which are outlined in Figure 27.

III.B.6

Feasible Alternatives

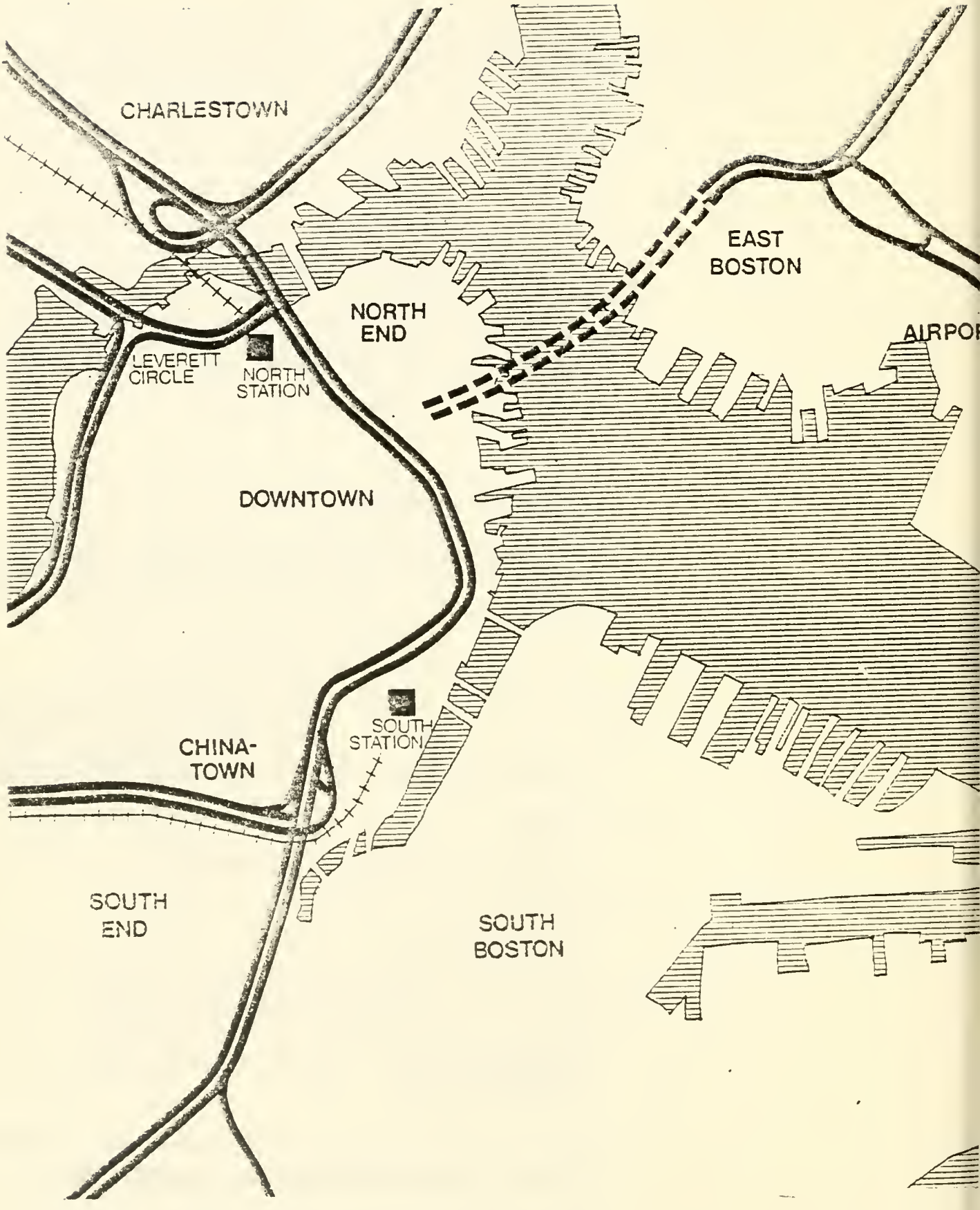
The alternatives which result from combining the options for the Central Area of the Artery Corridor are illustrated in the following figure:

Figure 27: Central Area Alternatives

	Without 3rd Harbor Tunnel	With 3rd Harbor Tunnel	
		Special Purpose	General Purpose
No Build	Alt. 1	Alt. 2	Alt. 3
Reconstruction Without South Area With Transitway	Alt. 4	Alt. 5	Alt. 6
Reconstruction With South Area With Transitway	Alt. 7	Alt. 8	Alt. 9

Alternative 1 - The No Build Alternative

The No Build Alternative has been developed to explore the possibility of retaining the existing elevated facility, with some modifications to it, in order to improve its functioning and useful life. The existing structure was erected



ALTERNATIVE 1: NO BUILD

Figure 2:

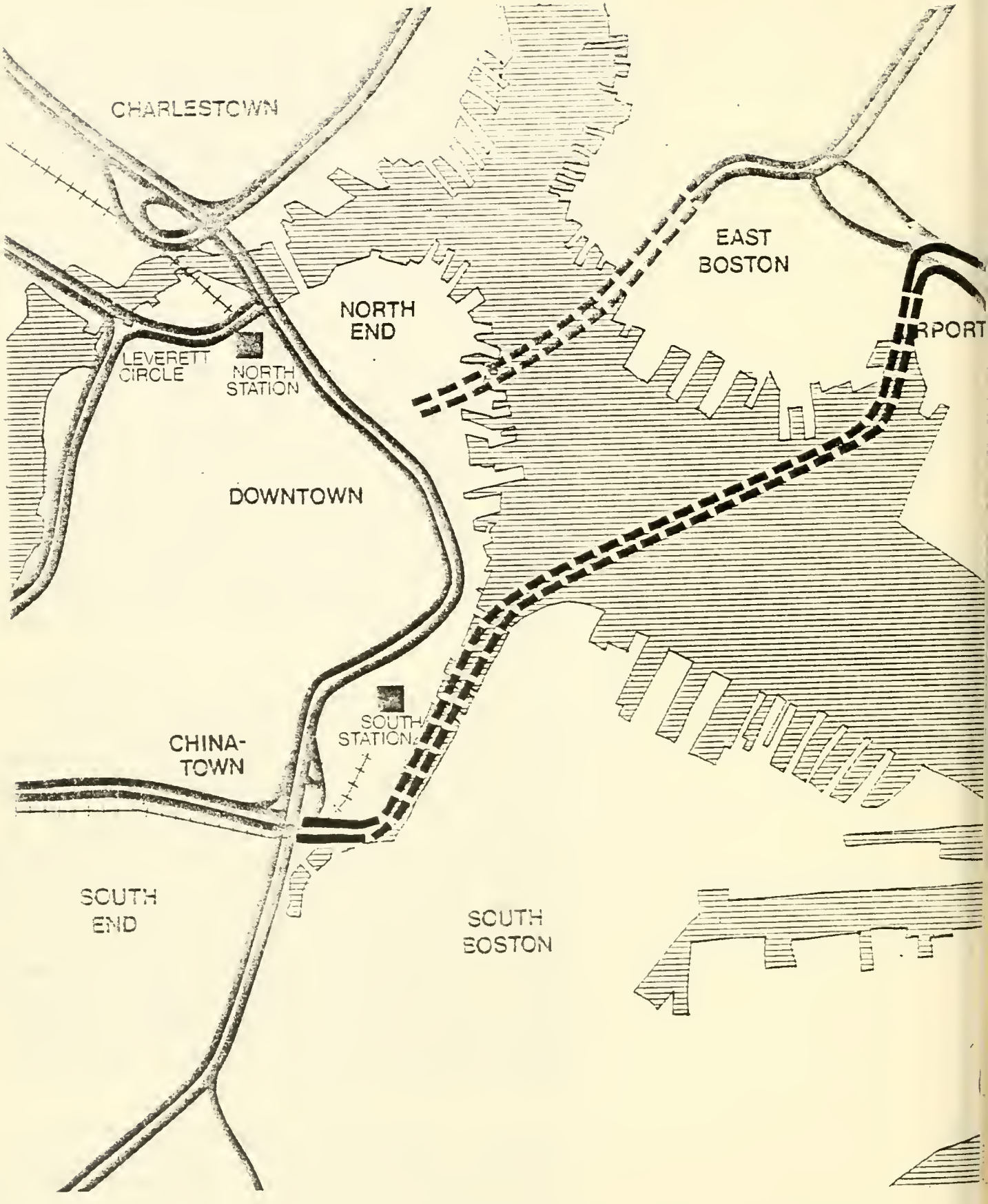
in 1954 through 1959, and roadways will be in need of major repair between 1984 and 1989. This 25-30 year time period is considered in responsible engineering practice to be the functional life of concrete decks on structures such as the Central Artery. While the decks in the Central Area have been constructed with a special coating to reduce deck deterioration, they will need replacement in any event in the relatively near future.

Deck replacement can be undertaken by one of three methods:

a. Rebuilding of one lane of the deck at a time. This method is the standard technique used in many instances of deck replacement throughout the Commonwealth. It has the substantial disadvantage of requiring the closure of one lane of the six during the rebuilding process, thereby restricting traffic severely in its use. Disruption from this option may be unacceptable. One of the problems of this method is in routing traffic on the expressway while work is underway. It has been estimated that this technique may take between three and five years.

b. Selective ramp rebuilding, replacement or addition prior to rebuilding the decks. As a modification of the option above, there are alterations or changes to ramps which can assist in reducing the disruptions of deck replacement. These include the following: Southbound ramps - removal of the ramp to Government Center; replacement of the ramp to Dock Square with a new ramp; construction of a new ramp from North Street to the southbound Artery; removal of the ramp to High Street; construction of a new ramp to Purchase Street. Northbound ramps cannot be significantly altered, because of the recent removal of two ramps (one from State Street, and one to Clinton Street) and reconstruction of a third - the ramp to the Callahan tunnel.

c. Partial widening of the Artery may be considered, along with deck replacement and modifications to ramps. The most constrained locations on the present structure can be modified by additional width of the facility in two locations: Southbound



ALTERNATIVE 2: NO BUILD
WITH SPECIAL PURPOSE HARBOR TUNNEL

Figure 2

between Clinton and State Streets, and northbound between Northern Avenue and the exit to the Callahan Tunnel. As a means of avoiding the impacts of traffic disruption during deck replacement, this partial widening may provide capacity to replace that lost to construction activity.

Alternative 1 has two options with regard to Artery improvements in the South Area: Alternative 1a, which does not include improvements in the South portion of the Corridor; Alternative 1b, which includes improvements in the South portion of the Corridor.

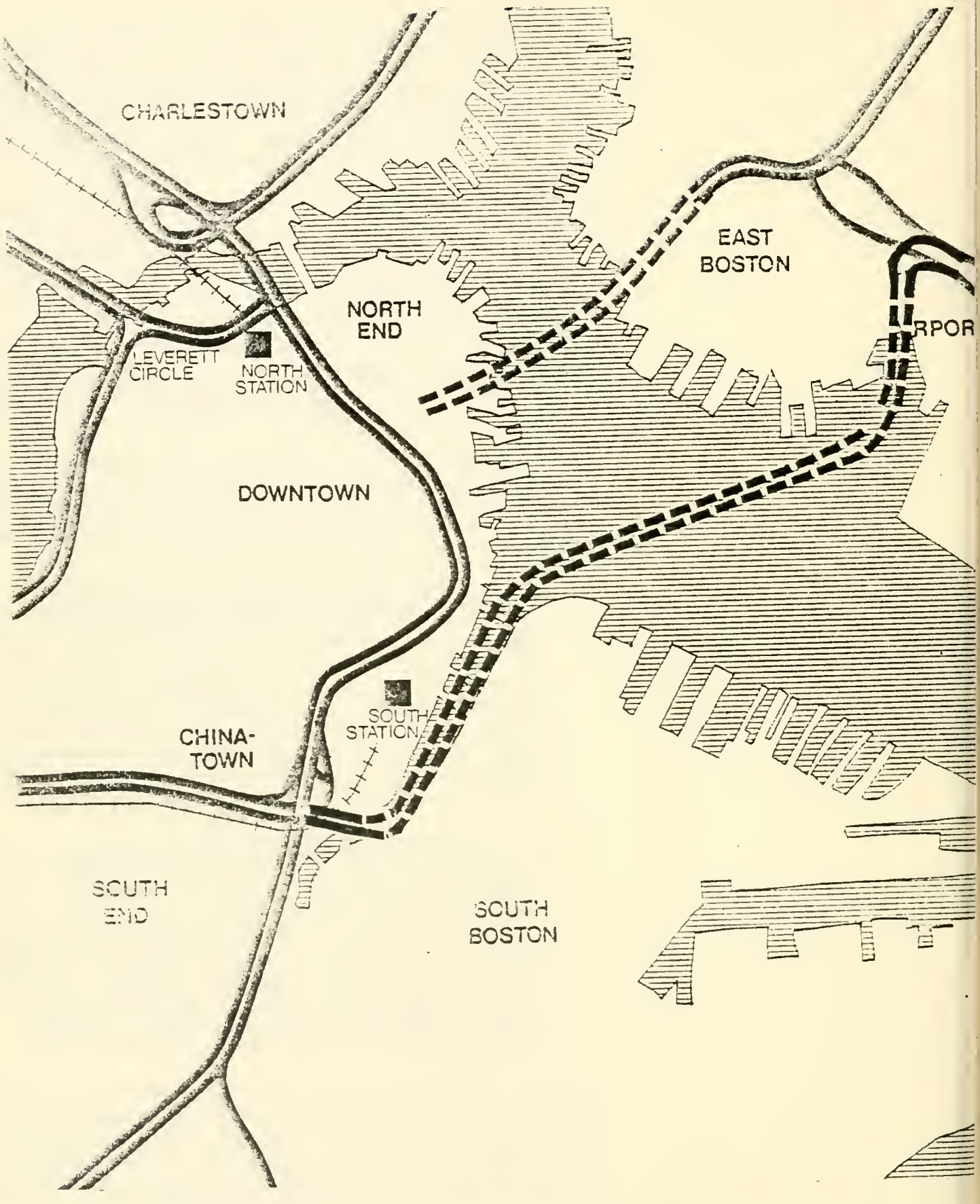
Alternative 2 - The No Build Alternative With a Special Purpose Third Harbor Tunnel

Alternative 2 is similar to Alternative 1 in all respects except its relation to the Third Harbor Crossing. With a Special Purpose Tunnel, there are two variations of tunnel approaches which are possible in the South Area:

2a Without South Area Artery Improvements
In this option, the approaches to the tunnel would be wholly contained within the Fort Point Channel. The existing Artery in the South Area--principally the Dewey Square Tunnel--would remain unchanged. Connections to and from the Tunnel would take place at the interchange between the Artery, the Southeast Expressway and the Massachusetts Turnpike.

2b With South Area Artery Improvements
In this option, the reconstruction of the South Area Artery would be complete: northbound Artery traffic would use a new one-way tunnel in the Fort Point Channel, while southbound Artery traffic would use the existing Dewey Square Tunnel. Connections between the Artery and the Third Harbor Tunnel would take place in the vicinity of the Northern Avenue Bridge.

Alternative 2a, which has no South Area improvements, would have serious disadvantages for the overall improvement of the Artery and upgrading its safety and operations. It would permanently foreclose the projected South Area improvements to the Artery and continue the existing substandard conditions in the Dewey Square Tunnel. While it would provide service to limited types of vehicles, it would primarily serve only those vehicles approaching it from the West and South.



ALTERNATIVE 3: NO BUILD

WITH GENERAL PURPOSE HARBOR TUNNEL

Figure 3

From other directions, such vehicles would have to travel the full length of the Artery to reach the Tunnel approaches. Although this option would remove some vehicles from the Central Area of the Corridor, it would increase travel time volumes and congestion in the South Area.

Alternative 2b includes the South Area improvements and would provide relief for the congestion in the existing Dewey Square Tunnel. With the retention of the existing elevated structure in the Central Area, the connection between the South Area and the Central Area would consist of a ramp extending from the northbound tunnel in the Fort Point Channel to the existing elevated structure, connecting to the elevated highway in the vicinity of Harbor Towers apartments.

Alternative 3 - The No Build Alternative With a General Purpose Third Harbor Tunnel

Alternative 3 is identical to Alternative 2 in all respects except its ability to divert traffic from the Central Area of the Artery. Through construction of a general purpose tunnel to the Airport, a larger proportion of the traffic now using the Central Area of the Artery Corridor may be diverted. The options are similar to Alternative 2:

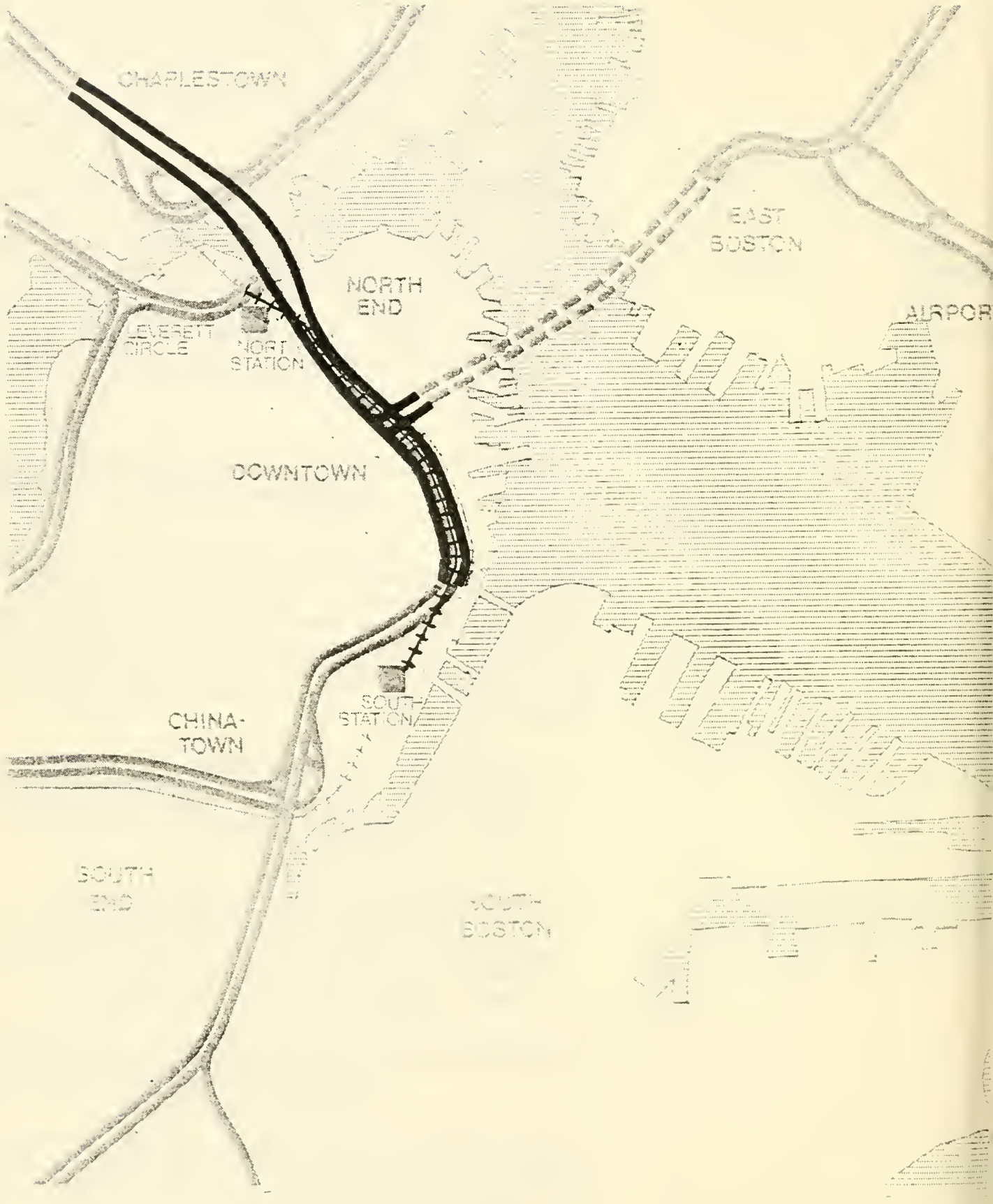
3a Without South Area Artery Improvements
Independent Third Harbor Tunnel approaches constructed entirely within the Fort Point Channel, with no change in the Artery's Dewey Square Tunnel.

3b With South Area Artery Improvements
Construction of the northbound approach to the Third Harbor Tunnel in the Fort Point Channel, with the return using the existing Dewey Square Tunnel of the Artery.

Alternative 4 - Reconstruction of the Central Area of the Artery Without the South Area Project

Reconstruction of the Central Area of the Artery Corridor may be desirable to maximize the transportation and environmental improvements which are needed in the Corridor.

Two major construction techniques have been analyzed:



ALTERNATIVE 4: RECONSTRUCTION
WITH NO OTHER MAJOR IMPROVEMENTS

Figure 31

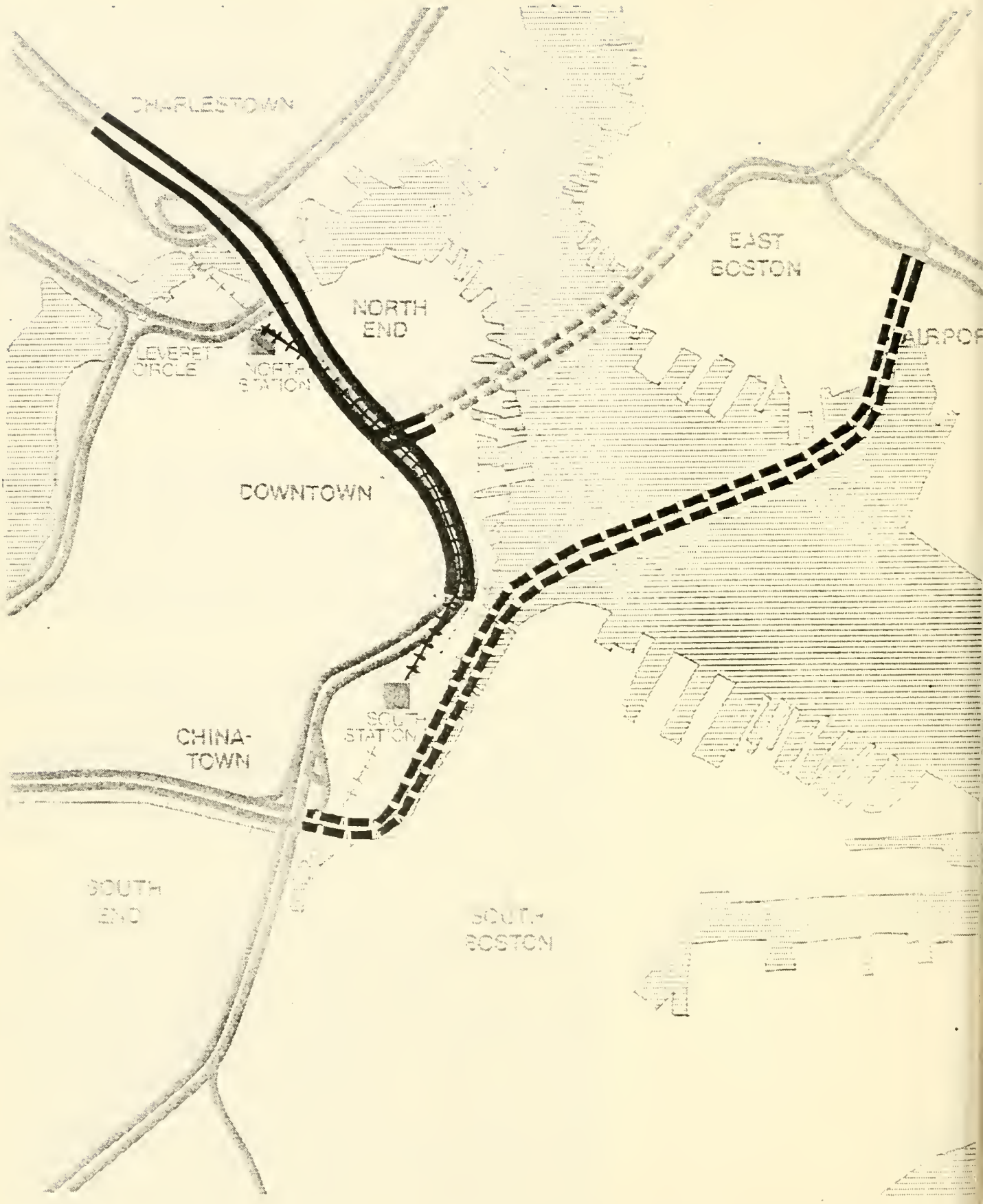
a. Reconstruction by erecting temporary one-way facilities that allow removal of half the Artery lanes and structure and onc-struction of half of the replacement tun-nel at a time. The technique is feasible, but the construction phasing is complex and disruption and land damages are extensive.

b. A second technique for reconstruction was subsequently explored, to allow the ex-isting structure to remain in place during the construction of the tunnel. In this option, the tunnel is constructed beneath the existing elevated Artery structure, and the existing facility is maintained for traffic until sufficient tunnel con-struction is completed to allow diversion of traffic from the elevated facility to the new tunnel.

Both of these techniques are feasible; however, (b) provides for less disruption to existing traffic during the construction period. It also offers the lesser construction period and affords fewer disruptions not only to traffic but to the adjacent areas. It is therefore the more probable form of reconstruction of the Artery.

The transit way connection between North and South Stations is a principal component in all reconstruction Alternatives (4 through 9). With construction technique (a) above, it is added when construction of the Artery tunnel is completed. With technique (b) above, the transit way tunnel is in the median of the new highway tunnel and therefore forms an integral portion of the proposed facility.

Alternative 4, the transition area in the vic-inity of the Dewey Square Tunnel at Congress Street would be subject to major disruption during the construction period. This is be-cause the roadway must be closed, and an alter-nate surface route for traffic found, to allow for connections between the existing Dewey Square Tunnel and the proposed tunnel in the Central Area. In addition, the finished pro-ject would not solve the problems of safety and congestion in the Dewey Square Tunnel. If this alternative were implemented, the South Area Project could be added at a later date. In Alternative 4 (and all other reconstruction alternatives) would be connected to the im-proved North Area of the Artery by two new bridges over the Charles River, replacing the existing high level, double decked bridge.

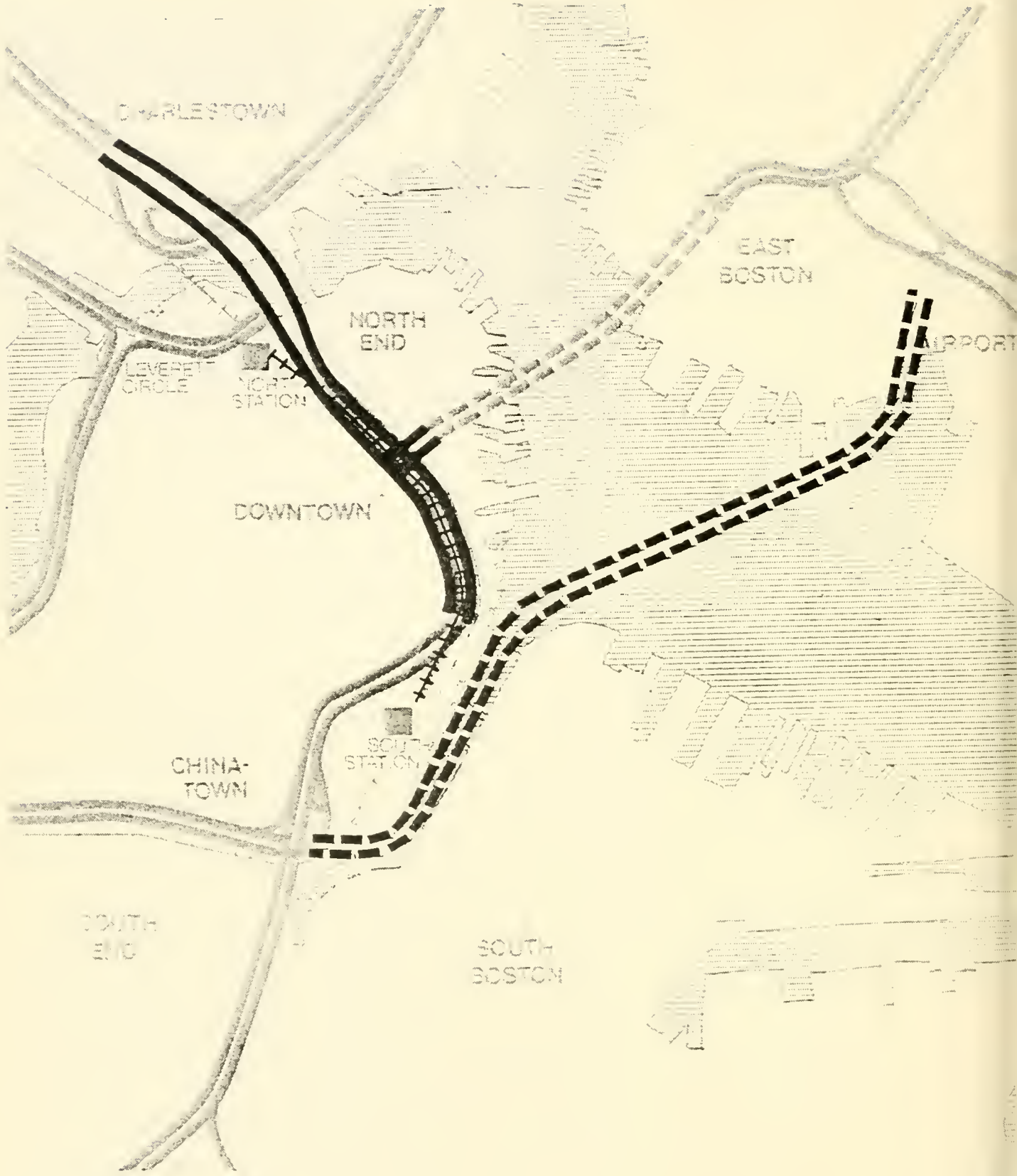


ALTERNATIVE 5: RECONSTRUCTION
WITH SPECIAL PURPOSE HARBOR TUNNEL

Figure 32

Alternative 5 - Reconstruction of the Central Area of the Artery Without the South Area Project and With the Special Purpose Third Harbor Tunnel

Alternative 5 is similar to Alternative 4, with the exception that the Third Harbor Tunnel would be constructed in the Fort Point Channel as a project independent of the South Area of the Artery Corridor. If constructed in this manner, the Third Harbor Tunnel would preclude subsequent improvements to the South Area of the Corridor. It would provide for new access for specific types of multiple occupancy vehicles to the Airport and would reduce the amount of traffic on both the South and Central Areas of the Corridor, to some extent.

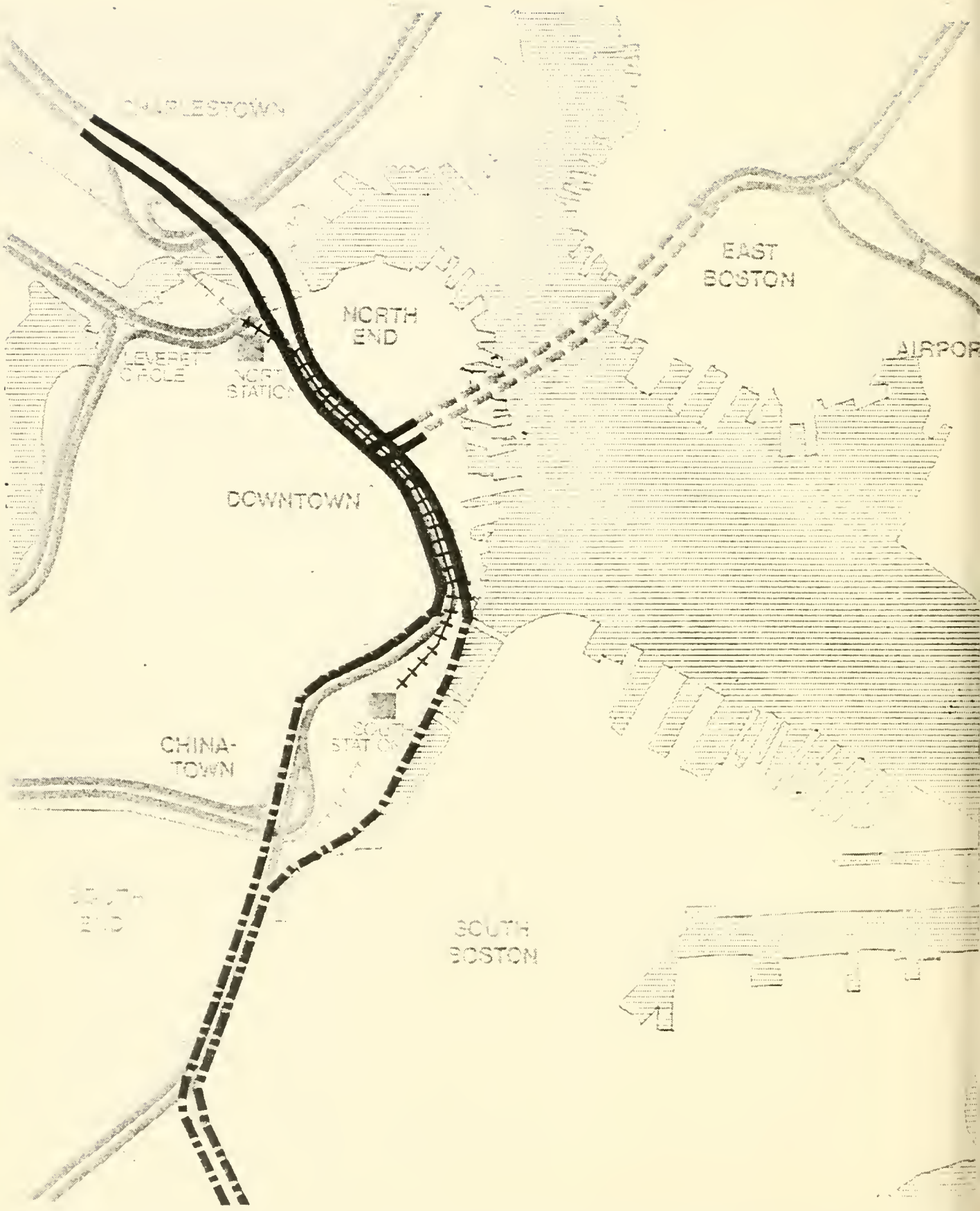


ALTERNATIVE 6: RECONSTRUCTION
WITH GENERAL PURPOSE HARBOR TUNNEL

Figure 33

Alternative 6 - Reconstruction of the Central Area of the Artery Without the South Area Project and With the General Purpose Third Harbor Tunnel

Alternative 6 is similar to Alternative 5 except that the Third Harbor Tunnel is a general purpose facility.

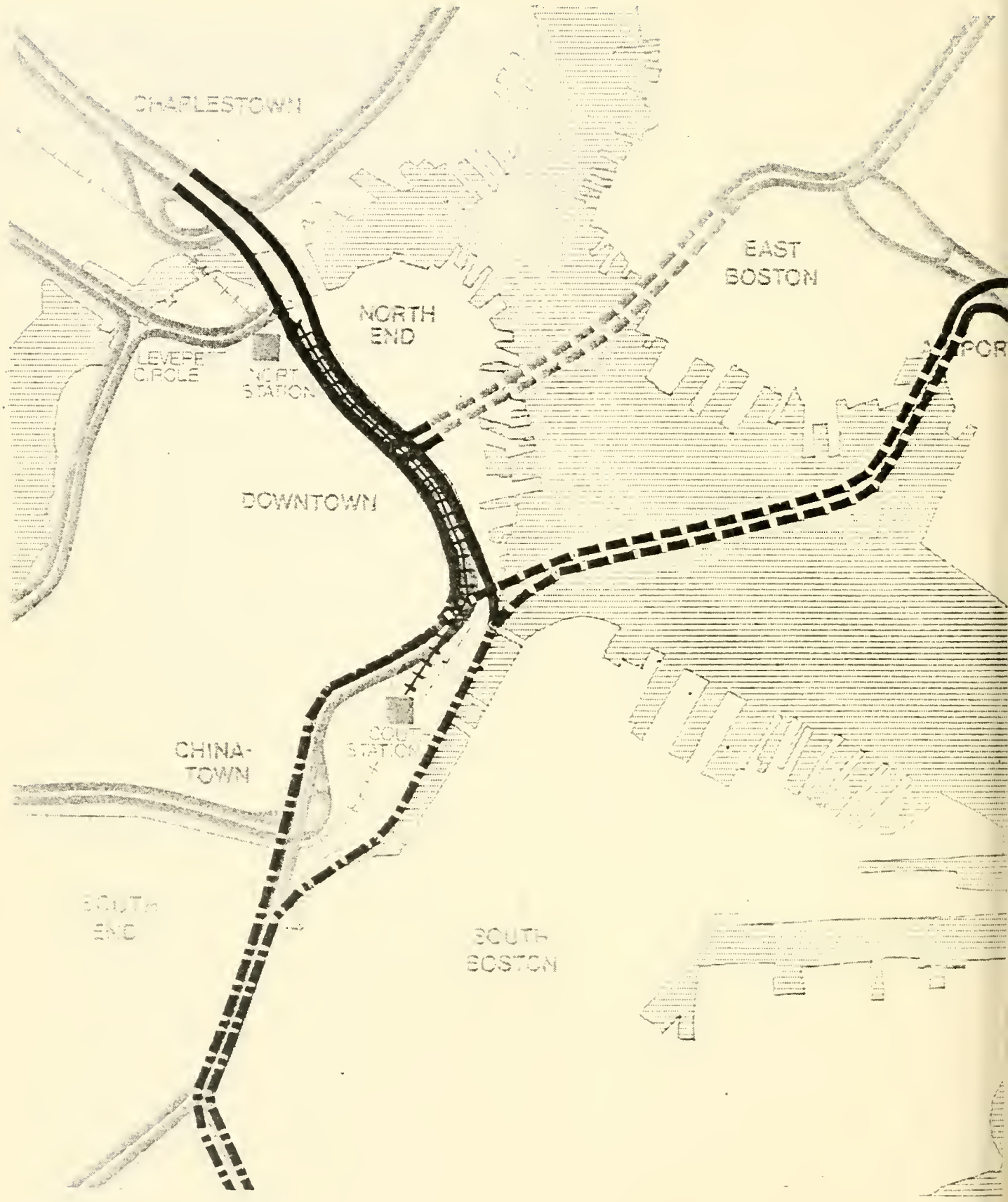


ALTERNATIVE 7: RECONSTRUCTION
WITH SOUTH AREA RECONSTRUCTION

Figure 34

Alternative 7 - Reconstruction of the Central Area of the Artery With The South Area Project

Alternative 7 calls for reconstruction of both the Central and South Areas of the Artery as distinct but related projects.



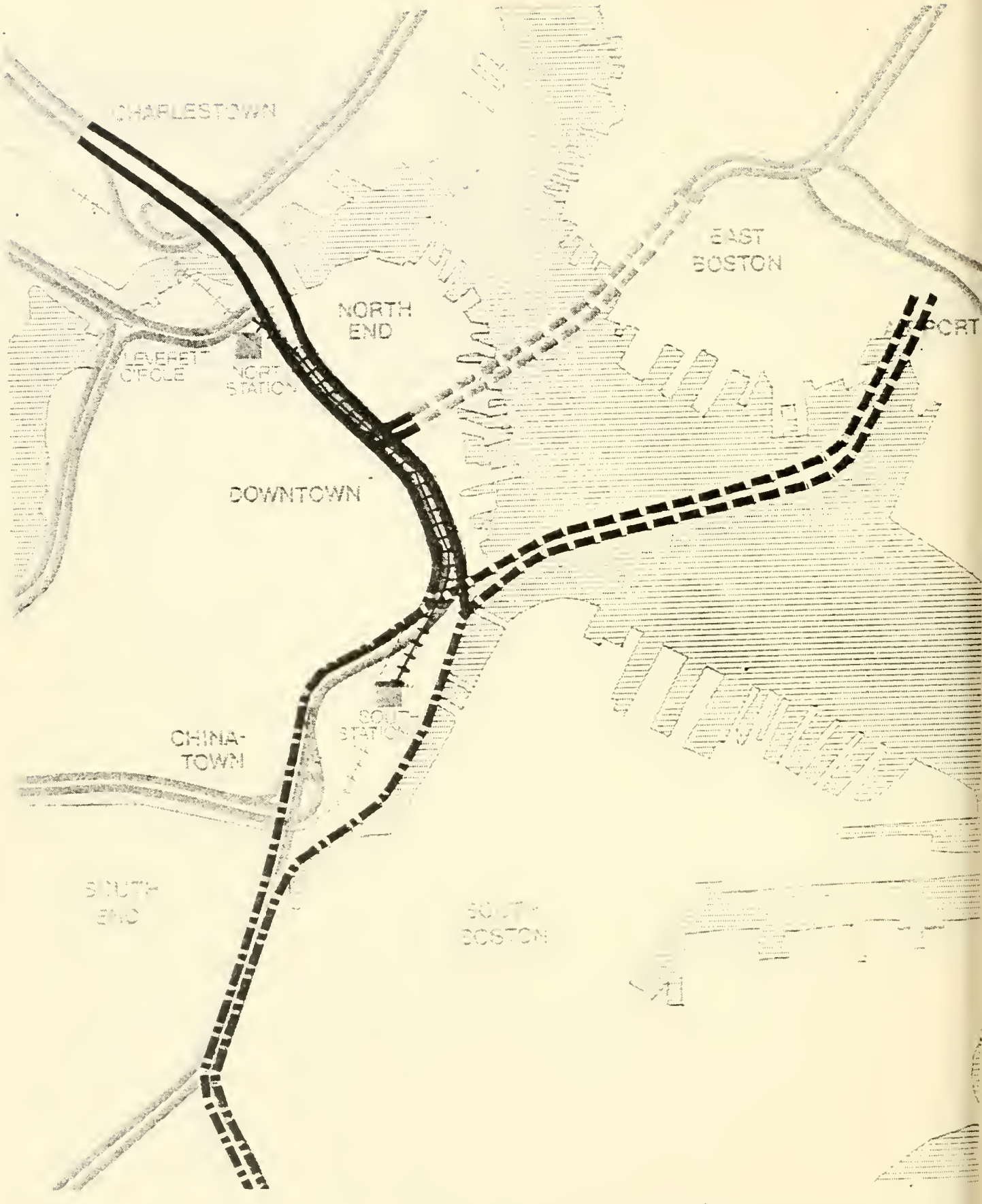
ALTERNATIVE 8: RECONSTRUCTION

Figure 35

WITH SPECIAL PURPOSE HARBOR TUNNEL AND SOUTH AREA RECONSTRUCTION

Alternative 8 - Reconstruction of the Central Area of the Artery With the South Area Project and With the Special Purpose Third Harbor Tunnel

Alternative 8 is similar to Alternative 7, with the addition of the Special Purpose Harbor Tunnel to the Airport. The connection between the Third Harbor Tunnel and the South Area Project would take place in the vicinity of Northern Avenue. It is anticipated that the addition of a Special Purpose Tunnel would reduce somewhat the number of vehicles using the Central Area of the Artery between the Sumner/Callahan Tunnels and the South Area of the Corridor.



ALTERNATIVE 9: RECONSTRUCTION

Figure 36

WITH GENERAL PURPOSE HARBOR TUNNEL AND SOUTH AREA RECONSTRUCTION

Alternative 9 - Reconstruction of the Central Area of the Artery without the South Area Project and with the General Purpose Third Harbor Tunnel

Alternative 9 is identical to Alternative 8, with the exception that the Third Harbor Tunnel would be constructed as a general purpose facility.

Integration with Transit

Opportunities for transit improvements in Downtown Boston have been considered along with the alternatives for highway improvements in the Central Artery. These opportunities are most evident in conjunction with the proposals for the Central Area of the corridor. This is because the Central Area is focal to the needs for distribution from all existing transit modes, converging on Downtown from all directions.

The existing network of transit facilities includes the elements listed below.

a. Commuter rail facilities from the Boston and Maine territory north of Downtown converge on North Station and terminate at the intermodal station where Orange and Green Line rapid transit stations provide downtown distribution. Commuter rail facilities from the Penn Central/Amtrak service the areas south of Downtown, which converge and terminate at South Station, where a Red Line rapid transit station provices downtown distribution.

b. Commuter bus facilities are distributed on all major expressways serving a variety of downtown stations:

1. Haymarket Station -for connections to the Orange and Green rapid transit facilities.

2. South Station -for connection to the Red Line.

3. Jordan Marsh (Chauncey St.)-for express bus connections to and from the west.

4. Trailways Station, Park Square- for Trailways, Almeida and Peter Pan services.

5. Greyhound Station on Stuart Street- for connections to Greyhound services and Vermont transit.

6. Other express bus services run on local streets in Downtown prior to terminating at one of the above station locations.

c. Rapid transit lines, most are underground in Downtown, and in most cases, form a through service. The Blue Line is the one exception to through service, It terminates in Government Center Downtown (at Bowdoin Station).

Problems in the existing transit network, which now converges on Downtown Boston, focus on the express and local bus system and the commuter rail network. Rail rapid transit services into and through Downtown are basically good, but all other services must transfer onto the rail transit network to reach desired destinations. This transfer is costly in travel time, as illustrated by the following chart of travel times between north and South Stations:

Figure 37:
Existing Travel Times between North and South Stations during Peak Hours

Pedestrian	30 minutes
Bus	23 minutes
Subway (one transfer)	17 minutes
Taxi	14 minutes

In addition, distribution to Downtown does not serve important areas of the city, where there are significant new developments which attract great numbers of people. The State Street/ Broad Street area immediately adjacent to the new Quincy Market is poorly served by nearly all transit services.

Three potential improvements which are closely related to the existing network and the possibility of improvements in the Central Area of the Artery are:

1. North Station Improvements
   Station improvements have been planned to extend the tracks to the concourse area of the station, and to provide direct pedestrian underground connections to the Orange Line at Causeway Street. These improvements have been held in abeyance pending the study of the Artery.

2. Green Line Relocation
The el on Causeway Street in front of North Station and extending northward toward Cambridge are currently programmed for replacement in the 1980's. An underground location for the facility is contemplated, and, because of the potential influence of the Artery project on connections to Leverett Circle, this project is closely related to Artery studies.

3. South Station Intermodal Transportation Improvements
These improvements are underway. However, the connections between the bus terminal and the expressway network are closely related to the Artery studies, in the South Area of the Corridor. Additional rail or bus services are closely related to the Central Area of the Artery.

III.B.8

Transit Opportunities

There are several opportunities for integrating transit services, along with improving the Central Area of the Artery. These include the Alternatives for the No Build as well as reconstruction of the Central Area of the Artery.

Transit and the No Build Alternatives
Transit options under the No Build Alternatives for the Central Area are more limited. The choices available focus on the potential for improving local and express bus services and new distribution possibilities in Downtown.

One option is the use of the surface Artery or portions of it for bus-only operation between expressway ramps and the Harbor tunnels. Another possibility is a combination of transportation systems management, such as ramp metering, to provide preferential treatment for buses.

Commuter Rail
The long-range plan for transportation improvements in the Boston region includes the retention and improvement of the existing network of commuter rail facilities. This plan calls for the retention of both North and South Stations as major termini for the commuter rail lines.

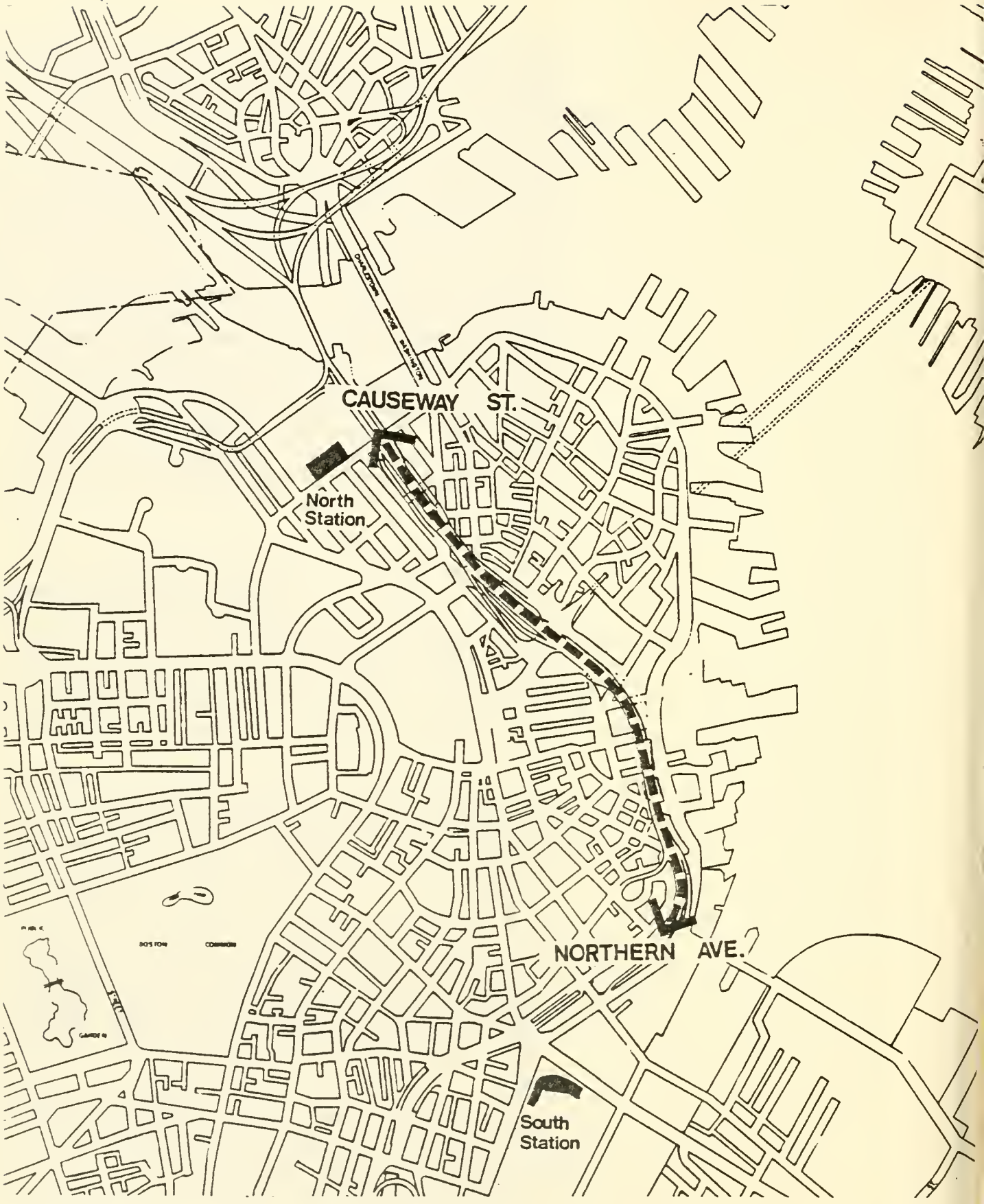
One of the possibilities opened by the study of the reconstruction of the Central Area of the Artery is the construction of a rail line between North and South Stations, to be constructed as an integral part of highway improvements. This connection would allow some of the commuter rail lines to pass through the Downtown area: North Station, State Street, South Station, and Back Bay Station. At North Station, connections could be made to the Green and Orange Line rapid transit facilities. At State Street Station interconnection could be made to the Blue Line serving the Airport and East Boston. At South Station interconnection can be made to the Red Line and all intercity rail and bus services provided by the proposed intermodal transfer facility. At Back Bay Station interconnection can be made to the Orange Line as well as the intercity rail lines.

Connections between the B&M Eastern Division and the New Hampshire Division to these downtown distribution points would be particularly helpful, since they do not have access to other rapid transit lines en route to the North Station. The two other rail lines served by North Station do have such connections with the Red Line at Porter Square, now under design, and the Orange Line at Oak Grove.

Express and Local Bus Services

Express bus services into Downtown now serve widely divergent locations at both public and private terminals. With the completion of the proposed intermodal transportation facility at South Station, there will be two principal locations: South Station and Haymarket Square. However, buses at both locations cannot readily penetrate other portions of Downtown because of the congestion on local streets and arterials. Local services into Downtown are similarly handicapped by congestion. Local routes from the north (Charlestown and Chelsea, for example) are now directed to a terminal at Haymarket Square. Local buses from the south use surface streets throughout Downtown to reach terminal locations.

A transit way for bus services could be constructed as part of the reconstruction alternatives on the Central Artery. If



NORTH-SOUTH TRANSITWAY CORRIDOR

Figure 3

built, the transitway could carry both express and local bus services not only into but through Downtown. Passengers could be offered a variety of distribution points--at North Station, at State Street and at South Station. The proposed transitway could be located in a tunnel in the median of the proposed Artery tunnel, with additional lateral width at station locations. At the south end of the Central Area, the tunnel could either exit onto local streets, be retained as part of the Artery tunnels in the South Section, or use the existing northbound Dewey Square Tunnel if the new northbound tunnel in the Fort Point Channel is constructed as part of the reconstruction of the South Area of the Corridor. A possible direct connection into the existing harbor tunnels or direct connections into the proposed Third Harbor Tunnel may be feasible with this Alternative.

Rapid Transit Services

The proposed transitway in the median of the Reconstructed Artery in the Central Area could also be used for rail rapid transit in any one of the technologies of existing MBTA lines. In addition, a bus tunnel could initially be constructed and later converted to rail transit use, when and if that becomes a more suitable mode for the corridor through Downtown.

Rail rapid transit modes which have been examined include the Blue Line which now terminates in Downtown and the Green Line which may become the mode for the proposed circumferential transit serving the core of the region. An additional possibility is a connection to the proposed Roxbury transit facility which is now being examined.

More detailed study must be accomplished before a particular rapid transit alternative can be developed and before a complete comparative analysis between transit modes, including bus and commuter rail, can be made.

III.B.9

Construction Feasibility

Few alternatives are available to improve the Artery. A new right-of-way is impossible to find - either in Downtown or in adjacent areas, because of environmental and community concerns, and because they fail to serve the transportation functions which the Artery now performs. The retention of the existing corridor leads to several solutions already outlined above. Each of these alternatives is feasible from a construction point-of-view, but they have differing impacts both during and after construction. The implications of each is discussed below.

III.B.9.a

No-Build Alternatives 1, 2, and 3

Rebuilding the decks of the Artery, including potential alterations to ramps or partial widening, is feasible from an engineering viewpoint. However, the social and environmental impacts of such construction are more significant and require further study. In addition, these alternatives do not meet current traffic and developmental demands, as well as long-term increases in these demands.

Any of the no-build alternatives can be constructed with or without the proposed North or South Area projects in the Artery Corridor, with minor changes in design. Construction techniques for each of the no-build alternatives are discussed earlier in this chapter.

III.B.9.b

Reconstruction Alternatives

All of the alternatives for reconstruction of the Central Area of the Artery share proposed construction technique alternatives:

Major construction techniques are possible:

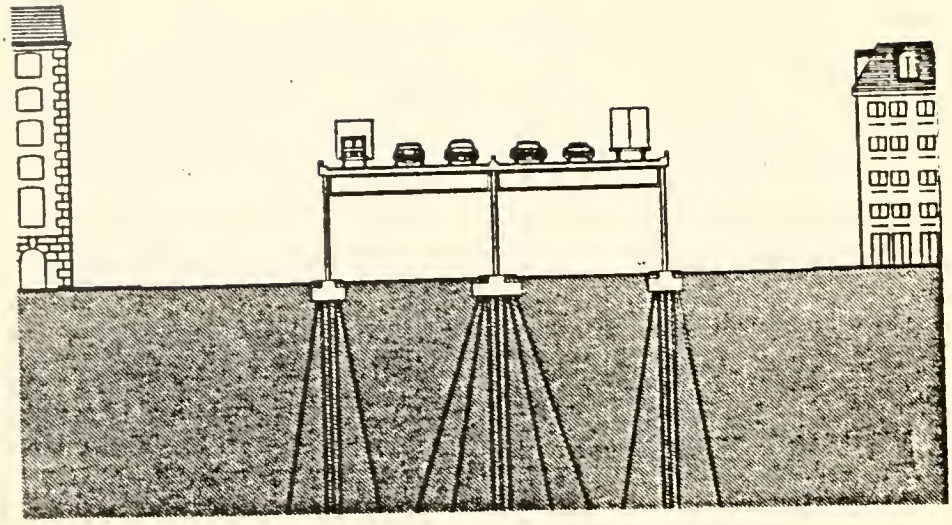
a. Reconstruction by erecting temporary one-way facilities that allow removal of half the Artery lanes and structure and construction of half of the replacement tunnel at a time. This

method, examined in a study commissioned by the MDPW and undertaken by the Boston Redevelopment Authority, suggested the construction of a parallel, three-lane elevated facility adjacent to the Artery, to allow for the removal of one-half of the existing elevated Artery structure. Within the space provided, one-half of the tunnel could be built and, when opened, would allow for the removal of the remainder of the existing elevated Artery structure. The technique is feasible, but the construction phasing is complex and disruption and land damages were extensive.

b. A second technique for reconstruction was subsequently explored, to allow the existing structure to remain in place during the construction of the tunnel. In this technique, the tunnel is constructed beneath the existing elevated Artery structure, and the existing facility is maintained for traffic until sufficient tunnel construction is completed to allow diversion of traffic from the elevated facility to the new tunnel. With traffic in the new tunnel, the existing structure is removed and the new tunnel is widened to full width and completed.

Both of these techniques are feasible; however, technique (a) causes greater disruption to existing traffic during the construction period. It also offers the longer construction period and affords greater disruptions not only to traffic but to the adjacent areas. Technique (b) has been examined by private, objective observers in the engineering and construction field, and found to be feasible from an engineering and construction point-of-view. It is, therefore, the more probable form of reconstruction of the Artery. Reconstruction would proceed as shown in the following simplified illustrations (Figures 39 through 47).

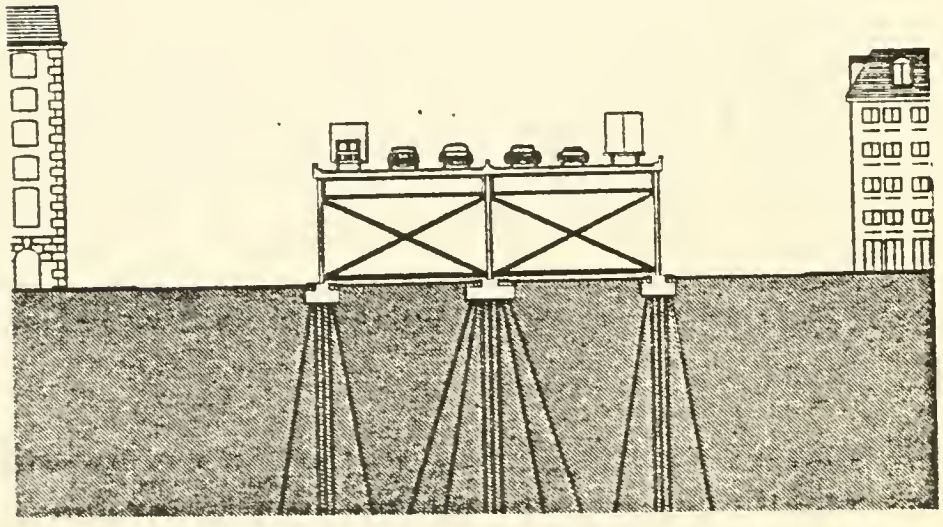
Prior to the first stage, analysis would be made of the subsoil conditions and the structure and foundations of the existing Artery. Figure 39 shows the existing construction of the Artery in cross-section, including the columns, the foundations, and the existing pile system.



EXISTING CONDITIONS

Figure 39

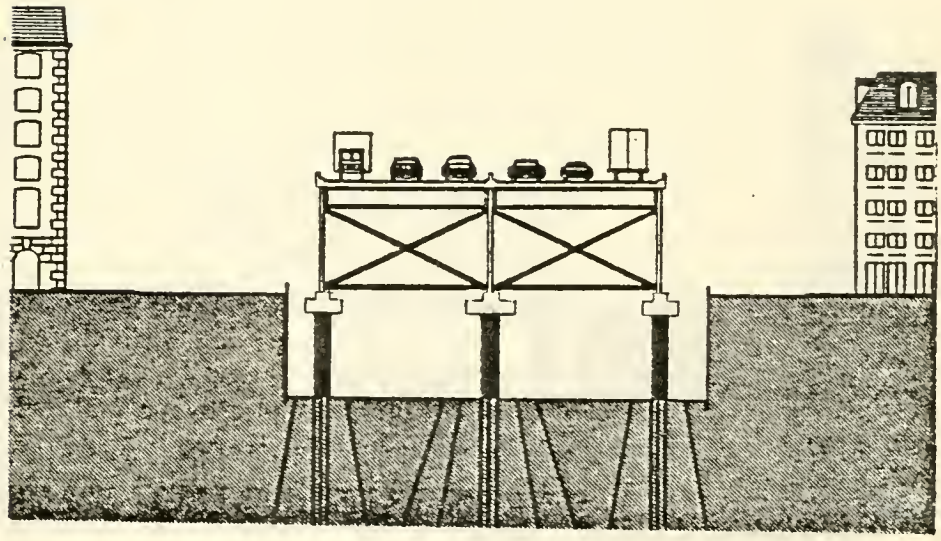
In the first stage, Figure 40, construction begins by strengthening the existing Artery with cross-bracing to provide additional support to the structure during excavation. Temporary street crossings are provided and utilities are either moved to a permanent location or temporarily relocated.



STAGE 1

Figure 40

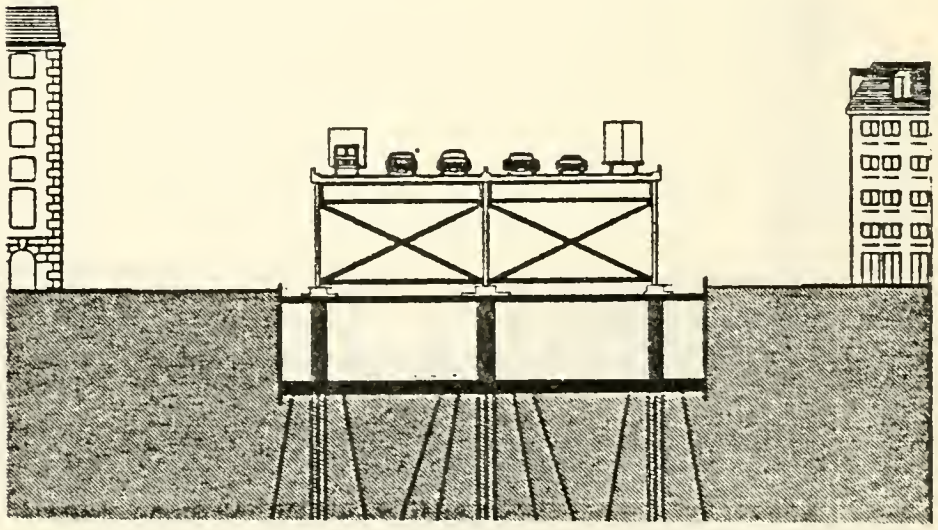
In the second stage, Figure 41, temporary retaining walls are placed and excavation reaches full depth. Vertical piles are collared and strengthened as excavation proceeds.



STAGE 2

Figure 41

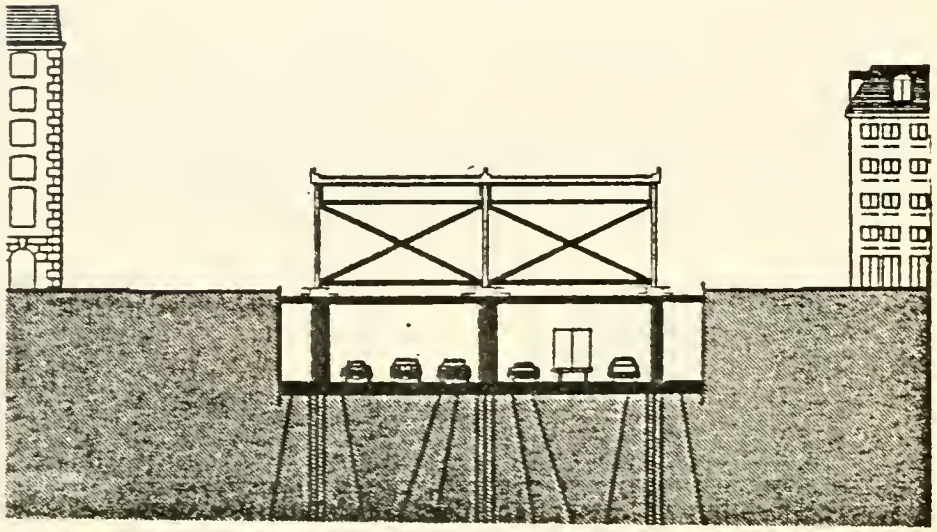
During stage three, Figure 42, the batter piles (the piles at an angle) are removed. The roof and floor of the new facility are then constructed.



STAGE 3

Figure 42

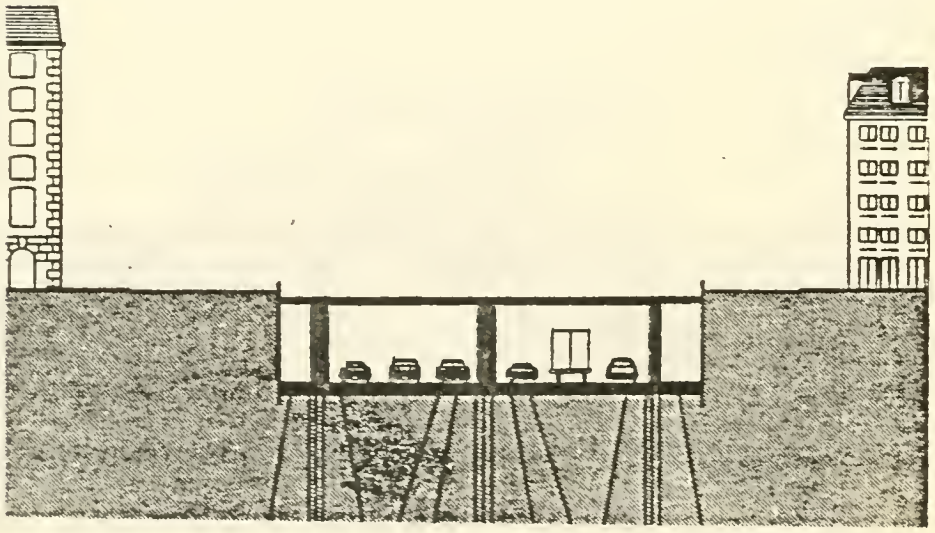
In stage four, traffic is moved from the Artery to the new tunnel, with three lanes in each direction replacing the existing lanes. Temporary ramps and connections to the surface streets and other expressways are provided.



STAGE 4

Figure 43

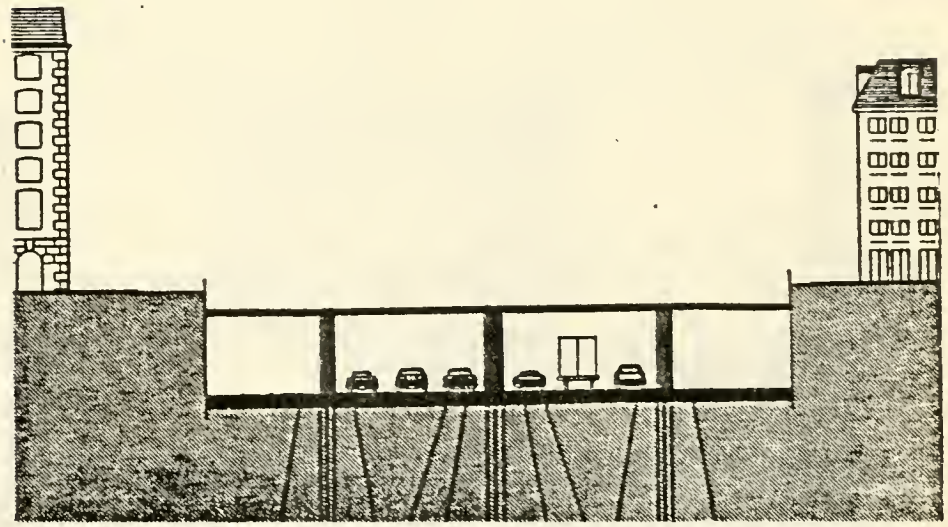
In the fifth stage, Figure 44, the existing elevated structure is dismantled and removed. This sets the stage for excavation required to reach full tunnel width.



STAGE 5

Figure 44

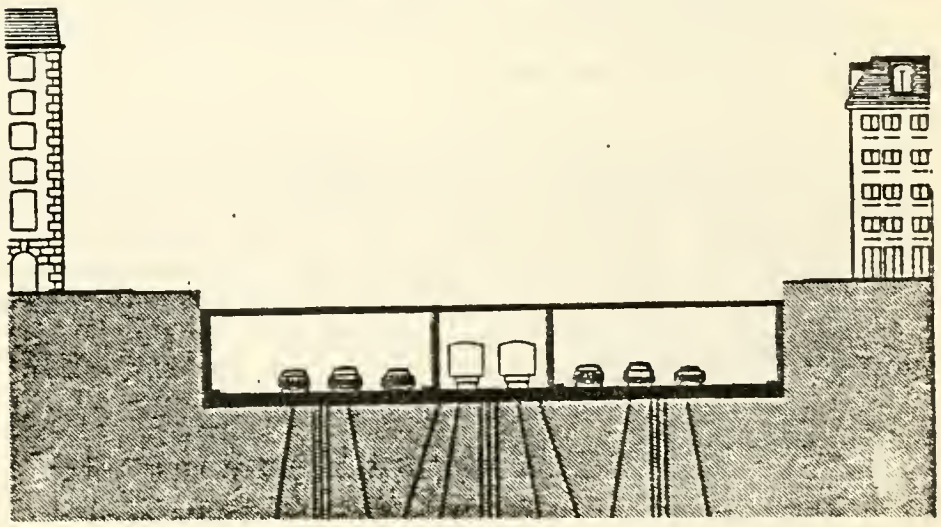
In stage six, Figure 45, new retaining walls are placed to allow excavation to the full width of the new tunnel. The permanent ramp connections to surface streets and other expressways are put into place.



STAGE 6

Figure 45

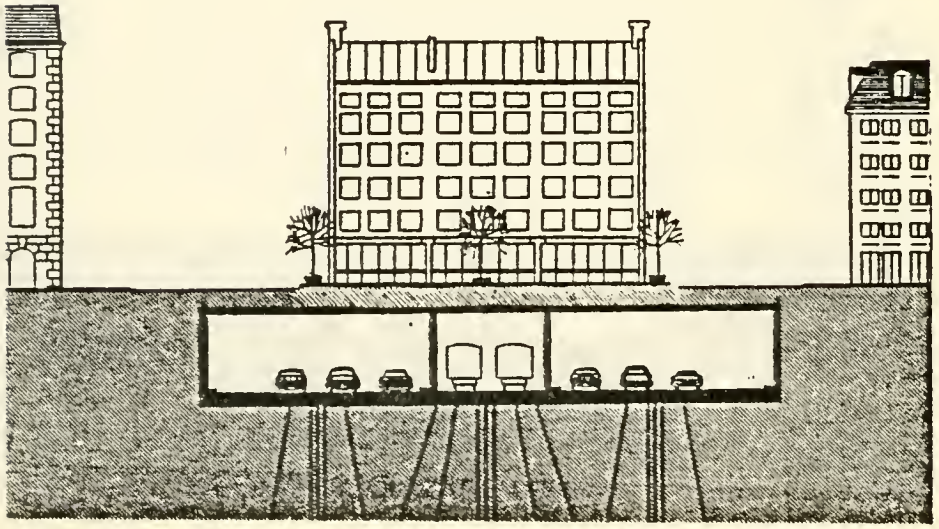
In stage seven, shown in Figure 46, the floor and roof of the new facility are extended to full width. Permanent walls and columns replace the temporary supports. Vehicles are now travelling in the permanent north- and southbound lanes and the space for the transit-way and stations is made available.



STAGE 7

Figure 46

In stage eight, Figure 47, fill is placed on the roof of the tunnel and the final grading and construction of surface streets, buildings and open space can be accomplished.



STAGE 8

Figure 47

The transit way connection between North and South Stations is a principal component in all reconstruction alternatives. In Technique (a), it is added when construction of the Artery tunnel is completed. In Technique (b), the transit way tunnel is in the median of the new highway tunnel and therefore forms an integral portion of the proposed facility.

Reconstruction of the Central Area of the Artery without the South Area project (Alternatives 4, 5 and 6) results in certain difficulties. Chief among these is the transition area between the new tunnels in the Central Area and the existing Dewey Square Tunnel. At this location, reconstruction will require temporary displacement of the expressway lanes onto surface streets. This would be done by construction of a new off-ramp southbound to Purchase Street. This ramp would replace the existing High Street ramp, which would then be demolished. With

the completion of the ramp, traffic from the Artery would be diverted onto Purchase Street for two blocks and back onto the Artery via the existing Congress Street southbound access ramp. The northbound movement would be made by diverting Artery traffic through the existing Northern Avenue off-ramp and onto the Artery via the existing Northern Avenue on-ramp. All of these ramps contain only two lanes each, and thus provide a serious restraint to traffic. All traffic would also proceed through surface street intersections during the construction period.

By diverting traffic in this way, the new connection between the existing Dewey Square Tunnel and the new Artery tunnel in the Central Area could be made. Estimated time of this construction phase and consequent traffic disruption is approximately 8 months. This period of disruption would occur in Alternatives 4,5 and 6. However, in Alternatives 5 and 6 the period of disruption would extend somewhat longer, due to the construction of the linkages required to be made into the new harbor tunnels. These connections would be made at the interchange area where the Mass. Turnpike joins the Central Artery at the mouth of the Dewey Square Tunnel (Kneeland Street). Although not properly a part of the Central Area, if constructed in this manner, the disruptive effects on traffic must be considered to be major.

Reconstruction of the Artery in Alternatives 7,8 and 9 is made easier by the existence of the South Area project. Joint phasing of construction will allow the connections of the two areas to be made conveniently, and without substantial disruption to traffic and local streets as in Alternatives 4,5, and 6. In Alternatives 7,8 and 9 the construction of the South Area project, and in particular, the Fort Point Channel tunnel will allow construction of the connection between the two areas to be made more easily because the traffic can be shifted back and forth between both the north and southbound portions of the Dewey Square Tunnel and the new Fort Point Channel Tunnel.

III.C ASSESSMENT OF IMPACTS

This discussion summarizes findings of analyses of the nine alternatives for the Central Area of the Central Artery Corridor. It is based on past studies and analyses of current proposals for Central Area improvements, the detailing of transportation impacts of the current proposals, and the social, economic and environmental consequences of alternative improvements. The following sections present the finding of the analyses - in the form of two charts, (see Figures 48 and 49) with explanations in the text. For purposes of analysis, the impacts shown are those which occur in the Central area of the Corridor only. Although some of the alternatives assume the implementation of the North and/or South Area improvements, the benefits which result from those proposals have not been included in this analysis. The methods of analysis for traffic, safety and environmental benefits are described in Chapter III and in Technical Appendices. All impacts have been computed for the date of opening and for three moving lanes in each direction, with shoulders used in peak periods to accomodate traffic demand.

III.C.1 Transportation Operational Improvements

Length of Queues

Queues in the Central Area of the Corridor are associated primarily with access onto the Artery, and in some cases, with access to facilities which link with it. Principal queuing areas are now found on the ramps leading from the major expressways into the Central Area - for example, the ramps from the Sumner Tunnel onto the Artery both north and southbound, the ramps onto the Artery from Leverett Circle/Storrow Drive, and the access to and from the Central Area via the existing Charles River Bridge. Since each of these ramps are of limited capacity, the effect of the queuing is to meter traffic onto and from the Artery.

The removal of each of the queues through the no-build alternatives (1,2 and 3) is not possible; they can only be mitigated in minor ways. For example, without major reconstruction at the mouths of the tunnels, access to and from the Artery will remain partially on the surface streets which provide the essential

IMPACTS / ALTERNATIVES	ALTERNATIVE 1: No Build	ALTERNATIVE 2: No Build with Special Purpose Tunnel	ALTERNATIVE 3: No Build with General Purpose Tunnel	ALTERNATIVE 4: Reconstruction Only	ALTERNATIVE 5: Reconstruction with Special Purpose Tunnel	ALTERNATIVE 6: Reconstruction with General Purpose Tunnel	ALTERNATIVE 7: Reconstruction with South Area Reconstruction	ALTERNATIVE 8: Reconstruction with South Area Reconstruction and a Special Purpose Tunnel	ALTERNATIVE 9: Reconstruction with South Area Reconstruction and a General Purpose Tunnel
Annual delay reduction (hrs in peak periods)	none; delay to increase over time	143,700	307,000	1,113,900	1,235,200	1,375,700	1,403,400	1,739,100	1,811,000
Average vehicle speeds (in peak periods)	17 mph	18 mph	18 mph	32 mph	33 mph	35 mph	40 mph	40 mph	40 mph
Annual value of time saved - auto (driver and passr	none; travel time penalties over time	$404,820	$850,720	$4,026,620	$4,211,480	$4,469,660	$4,636,320	$4,810,780	$4,985,240
Annual value of time saved - bus passenger	none; travel time penalties over time	$195,300	$344,300	$1,201,900	$1,286,400	$1,387,800	$1,401,200	$1,462,300	$1,536,900
Annual value of vehicle hours saved - busses	none; travel time penalties over time	$ 11,400	$ 20,000	$ 70,500	$ 74,800	$ 80,700	$ 81,500	$ 85,000	$ 89,400
Annual value of veh.hrs saved - commercial veh.	none; travel time penalties over time	$ 19,600	$ 45,300	$ 713,800	$ 802,900	$ 903,300	$ 924,400	$1,200,200	$1,247,100
Annual operating savings - all vehicles	none; increased costs over time	$ 24,800	$ 57,300	$ 903,300	$ 910,000	$ 920,000	$ 942,600	$ 942,600	$ 942,600
Annual number of accidents	262	244	236	61	55	55	61	55	55
Annual accident reduction - percent	none	-5%	-10%	-77%	-79%	-79%	-77%	-79%	-79%
Annual accident reduction - dollar savings	none	$ 41,000	$121,000	$ 824,000	$ 853,000	$ 853,000	$ 824,000	$ 853,000	$ 853,000
Interstate standards	no	no	no	improved	improved	improved	improved	improved	improved

Note: For purposes of analysis, No Build Alternatives do not include major alterations to existing structures

Figure 48: Summary of Anticipated Transportation Impacts

IMPACTS / ALTERNATIVES	ALTERNATIVE 1: No Build	ALTERNATIVE 2: No Build with Special Purpose Tunnel	ALTERNATIVE 3: No Build with General Purpose Tunnel	ALTERNATIVE 4: Reconstruction Only	ALTERNATIVE 5: Reconstruction with Special Purpose Tunnel	ALTERNATIVE 6: Reconstruction with General Purpose Tunnel	ALTERNATIVE 7: Reconstruction with South Area Reconstruction	ALTERNATIVE 8: Reconstruction with South Area Reconstruction and a Special Purpose Tunnel	ALTERNATIVE 9: Reconstruction with South Area Reconstruction and a General Purpose Tunnel
Direct tax base impacts	no change	no change	no change	positive	positive	positive	positive	positive	positive
Net new acres for development	0	0	0	20 Acres	20 Acres	20 Acres	20 Acres	20 Acres	20 Acres
Dollar value of land for new development	none	none	none	$ 6,897,000 $16,417,000	$ 6,897,000 $16,417,000	$ 6,897,000 $16,417,000	$ 6,897,000 $16,417,000	$ 6,897,000 $16,417,000	$ 6,897,000 $16,417,000
Impact on community quality and character	no change	no change	no change	major positive	major positive	major positive	major positive	major positive	major positive
Air quality impacts Tons/year	CO: 5220 HC: 570 NOx: 430	CO: 5350 HC: 580 NOx: 430	CO: 4190 HC: 550 NOx: 390	CO: 2590 HC: 330 NOx: 570	CO: 2610 HC: 360 NOx: 570	CO: 2450 HC: 340 NOx: 550	CO: 1830 HC: 290 NOx: 620	CO: 1910 HC: 300 NOx: 620	CO: 1730 HC: 280 NOx: 590
Noise impacts	no change	no change	no change	major improvement	major improvement	major improvement	major improvement	major improvement	major improvement
Water quality impacts	no change	no change	no change	slight improvement	slight improvement	slight improvement	slight improvement	slight improvement.	slight improvement
Overall impact - north of Causeway St.	negative	negative	negative	positive	positive	positive	positive	positive	positive
Overall impact - south of Causeway St.	negative	negative	negative	major positive	major positive	major positive	major positive	major positive	major positive
Project life	30 yrs-deck	30 yrs-deck	30 yrs-deck	40 yrs-tunnel 30 yrs-deck	40 yrs-tunnel 30 yrs-deck	40 yrs-tunnel 30 yrs-deck	40 yrs-tunnel 30 yrs-deck	40 yrs-tunnel 30 yrs-deck	40 yrs-tunnel 30 yrs-deck
Construction costs - Central Area Artery project (000)	$25,800 to $32,400	$25,800 to $32,400	$25,800 to $32,400	$1,015,000	$1,015,000	$1,015,000	$1,015,000	$1,015,000	$1,015,000
Construction costs - related projects (000)	none	$409,940 - independent tunnel	$634,420 - independent tunnel	$75,000 - North Area only	$484,940 - North Area & Ind. tunnel	$709,420 - North Area & Ind. tunnel	$265,580 - North & South Areas	$578,340 - North, South & tunnel	$656,300 - North, South & tunnel
Construction duration	3-5 years	3-5 years plus 4 yrs for tunnel	3-5 years plus 5 yrs for tunnel	6-8 years	6-8 years plus 4 yrs for tunnel	6-8 years plus 5 yrs for tunnel	6-8 years	6-8 years plus 4 yrs for tunnel	6-8 years plus 5 yrs for tunnel
Types of construction disruption	Moderate to severe	Moderate to severe	Moderate to severe	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate

Note: For purposes of analysis, No Build Alternatives do not include major alterations to existing structures

Figure 49: Summary of Environmental and Community Impacts

links. Queues from tunnel ramps are perhaps the most severe for Artery operations, because traffic frequently backs up on the Artery when the tunnels congest.

Congestion on other ramps places extreme loads on connecting facilities. The Leverett Circle/ Storrow Drive connection to the Artery, which is signalized at Leverett Circle, causes severe afternoon congestion on both Storrow Drive and McGrath Highway. These two roadways with a combined inbound capacity of five lanes lead to the two-lane access ramp to the Artery. This access ramp, which serves all north and southbound expressway traffic coming from Leverett Circle, meters traffic onto the Artery. This limitation on traffic - along with many others - will not be relieved by the no-build solutions.

With direct underground tunnels for all expressway connections, conflicts with surface street traffic are avoided. Connections with the improved North Area (via two new bridges over the Charles River to replace the existing bridge) will remove the present limitations of the Charles River crossing. Proposed access to and from surface streets will be balanced for the needs of through trips and flow more smoothly. Because of this queuing on the proposed reconstruction alternatives (4 through 9) will be minimal because the capacity of the proposed facilities will be increased. Although in some cases, the metering of traffic to and through the Artery Corridor will be partially retained, the net effect of the improvement will be to reduce queues on both the mainline of the Artery and on connections to it. Such queuing as may remain will be removed from the Artery facility and provided for with adequate storage space on either ramps or connecting surface streets.

Annual Delay Reduction (Hours in peak periods)

Delay reductions on the Artery are expressed in the following list. (Note: this does not include delay reduction on either connecting expressway facilities or on local surface streets.) Anticipated speeds in peak hours follow.

Alternative 1 - none; delays are expected to increase over time, commensurate with increasing traffic on all facilities.

Alternative 2 - 139,565 hours/annually
Alternative 3 - 277,865 hours/annually
Alternative 4 - 1,218,254 hours/annually
Alternative 5 - 1,278,614 hours/annually
Alternative 6 - 1,362,156 hours/annually
Alternative 7 - 1,404,079 hours/annually
Alternative 8 - 1,458,840 hours/annually
Alternative 9 - 1,516,760 hours/annually

Average Vehicle Speed in Peak Period

Alternative 1 - 17 mph
Alternative 2 - 18 mph
Alternative 3 - 18 mph
Alternative 4 - 32 mph
Alternative 5 - 32 mph
Alternative 6 - 33 mph
Alternative 7 - 40 mph
Alternative 8 - 40 mph
Alternative 9 - 40 mph

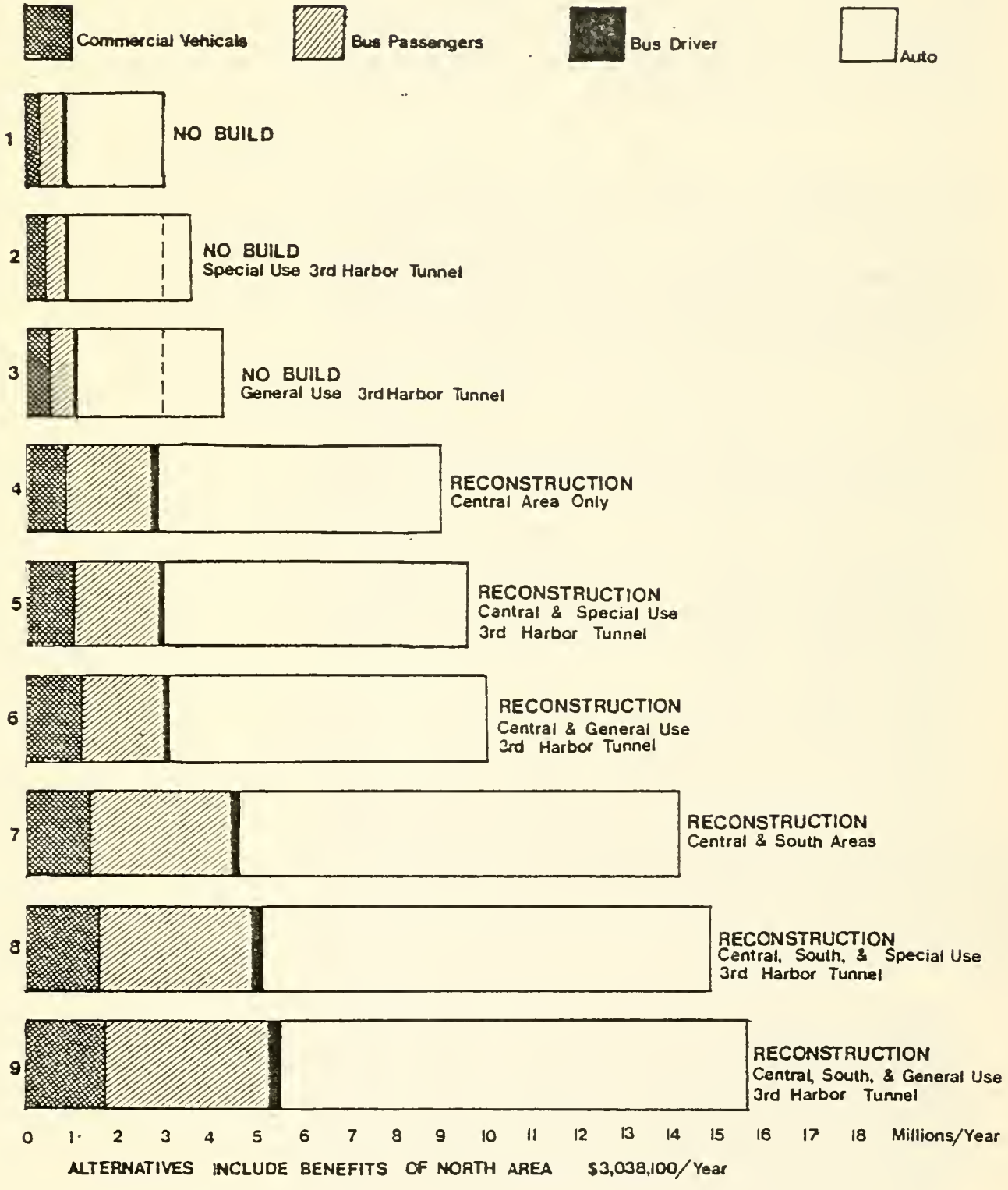
Annual Value of Time Saved in Peak Periods

Figure 50 illustrates the benefits of time savings to varying road users, projected as a result of implementing each of the alternatives. These figures are expressed for the year in which each alternative would be open and used; values are expressed in 1975 dollars for comparative purposes. Each alternative also reflects highway system analyses which include induced, new and diverted trips resulting from implementation of the proposed improvements.

A conservative approach has been adopted in presenting the anticipated benefits; that is, benefits are shown only for peak hours and only for users of the Central Area of the Artery Corridor. Benefits from the implementation of proposed improvements in other portions of the Artery Corridor are not included in the chart. The chart thus gives a modest picture of anticipated benefits, however the analysis has been expanded below for comparative purposes.

Figure 50 shows the benefits which would accrue to the entire corridor if improvements were made not only to the Central Area, but also to the North and South areas of the Corridor. Alternative 1 - the base case - indicated time savings attributable only to North Area improvements. Alternatives 2 and 3 show the additional time savings which accrue to travellers in the Central Area of

Figure 50 **VALUE OF TRAVEL TIME SAVED IN PEAK HOURS**



the Corridor if North Area improvements are made and independent tunnels for the Third harbor crossing are constructed in the Fort Point Channel; these include no South Area improvements to the Artery. However, there are some benefits to the South Area from implementation of the independent tunnels; these have been shown as dashed line additions to the bar of improvements in the Central Area.

Alternatives 4, 5 and 6 are also shown with the increment of North Area improvements, because reconstruction of the Central Area proposed in these alternatives requires the implementation of the proposed North Area improvement, (South Area benefits are not shown because these alternatives do not include the South Area improvements.)

The greatest benefits to the Artery Corridor occur in Alternatives 7, 8 and 9 - each of which includes the benefits from the implementation of improvements to all parts of the Corridor. The proposed improvements to the North Area and to the South Area provide benefits which have been included in these measures of Central Area benefits. The sum of resulting benefits is greater with all elements in place, than if either the Central or the South Areas were improved.

It is noteworthy that the implementation of the harbor crossing elements do not provide significant increments of benefits to travellers in the Artery Corridor. These benefits are shown graphically by the differential between the length of the bar for Alternative 4 as compared to 5 and 6, and, to Alternative 7 as compared to 8 and 9.

Annual Operating Savings in Peak Periods-All Vehicles

Costs of operating vehicles are major for all users, and especially so in peak periods when delays and queueing most often occur. The following chart shows the operational savings for all vehicles which result in peak periods following implementation of each of the alternatives. These benefits are expressed for the year in which each alternative would be open for use; they are shown in 1975 dollars for comparison.

Alternative 1 -	None
Alternative 2 -	$ 24,800
Alternative 3 -	$ 57,300
Alternative 4 -	$ 903,300
Alternative 5 -	$ 910,000
Alternative 6 -	$ 920,000
Alternative 7 -	$ 942,600
Alternative 8 -	$ 942,600
Alternative 9 -	$ 942,600

III.C.2

Safety

Accident Reduction

The table below reflects estimated annual accidents for each of the alternatives, including the percent of reduction from the base case (Alternative 1) and the dollar value which is assignable to the accident reduction for each.

Alternative	Annual No. Accidents	Percent Reduction	Dollar Savings
1	262	-0%	$ 0
2	249	-5%	$ 41,000
3	236	-10%	$121,000
4	61	-77%	$824,000
5	55	-79%	$853,000
6	55	-79%	$853,000
7	61	-77%	$824,000
8	55	-79%	$853,000
9	55	-79%	$853,000

Interstate Standards

Alternatives 1, 2 and 3 do not meet interstate standards. Improvements will not change Artery conditions relative to these standards. Alternatives 4 through 9 will improve roadway configuration and performance, bringing the Artery close to conformance with the standards.

III.C.3 Regional and Community Impacts

The Artery affects the economic vitality of all Downtown Boston, which is not only the core of the metropolitan area, but the economic and cultural focus of the entire New England Region. The proposed improvement alternatives affect both the local community and the metropolitan and New England regions in different ways.

Alternative 1, 2 and 3 provide no opportunities to enhance the growth and development of Downtown Boston. Even if operational improvements were made, the negative effects of the present facility would remain. Traffic would continue to spill onto local streets to avoid the Artery, and the negative impacts of the Artery on adjacent land parcels would continue to constrain development possibilities. The improvements of Alternatives 1, 2 and 3 not only continue the negative impacts of the Artery, but prolong the period of these impacts of the present facility into the long-range future.

Alternatives 4 through 9, on the other hand, afford the possibility of implementing a long-range strategy for the improvement of the economic future of the Downtown area. The removal of the constraint posed by the Artery will enhance development possibilities on lands which are adjacent to the Artery. In addition, new opportunities arise for development on the decks over the tunneled Artery. In transportation terms, the impacts caused presently by spillover of traffic onto local streets will be reduced. Improved accessibility resulting from the rebuilt Artery will enhance properties within and adjacent to the Artery Corridor. Since much of this property is in the heart of the metropolitan area, this is a major benefit for the implementation of state and federal policy aimed at the restoration and enhancement of older urban centers. Improvements made through Alternatives 4 through 9 will last not only for the immediate future, but also for the very long-term future of Downtown Boston.

Tax Base and Development Impacts

Alternatives 1,2 and 3 would have no impacts on the tax base nor would they provide new acreage for development. Alternatives 4 through 9 have tax base impacts in both the taking of properties and the reinstitution of new uses made possible through the highway improvements. Tax losses would be incurred in the taking of the Anelex Building and other industrial properties in the vicinity of Causeway Street. These losses could be offset with the possible positive tax advantages resulting from the development of new buildings on parcels created within the highway right-of-way, above the new tunnels. Additional advantages may accrue to

adjacent parcels which become easier to develop by virtue of the removal of the negative influence of the present elevated highway. These second order positive impacts result by the area becoming more attractive in general for investment in new development of vacant land or in reuse of existing structures.

Impact on Community Quality and Character

This is an overall impact evaluation of factors which are difficult to quantify but which reflect community and environmental concerns. These include visual and aesthetic qualities, pedestrian amenities and the local street pattern and its relation to the expressway network.

Alternatives 1, 2 and 3

No change in community quality character over the present situation. The present negative influence of the transportation facilities in the area will continue.

Alternatives 4 through 9

North Causeway street, these alternatives remove the complex of overhead highway ramps adjacent to and above the Charles River. The new facilities will intrude considerably less on the environment, and their low profile should enhance the visual appearance of the area. South of Causeway Street, these alternatives are entirely in tunnel. There should therefore be a major positive impact on the environment in this portion of the Corridor. This is particularly significant because of the land uses - both residential and commercial- which lie adjacent to the right-of-way, and which represent some of the most intensely used areas of the metropolitan region.

Overall Impact - North of Causeway Street

Alternatives 1,2 and 3 will have continued major negative traffic and environmental impacts in this portion of the corridor. These include continued and growing congestion, associated air and noise impacts from expressway and local street operations, spillover of traffic onto local streets, and the continued blighting influence of expressway constraints and operations. Opportunities for improvements

would be constrained as a result of the continued negative impacts of the high-level bridge over the Charles River and the expressway connections to both the bridge and the Artery mainline.

Alternatives 4 through 9 produce major positive transportation improvements in this part of the Corridor. Environmental impacts should be positively altered, through the construction of new transportation facilities which are more in scale with the river crossing area and with the North Station vicinity. Opportunities for joint development in the area are opened, with the possibility of constructing transit facilities either concurrently or conjunctively with the highway improvements. These include the construction of a replacement Green Line so that the existing elevated line can be removed from Causeway Street, and the construction of a transitway in the median of the reconstructed Artery to provide new transit opportunities for the entire corridor.

Each of the reconstruction alternatives will produce major transportation improvements in the area. These include reduced congestion and delays for all types of traffic, decreased accidents on expressways and local streets and reduction of environmental impacts associated with transportation operations.

III.C.4

Environmental Impacts

Projected Noise Impacts

Two aspects of the proposed reconstruction of the Central Section have the potential to alter the noise climate in the corridor traversed by the roadway:

1. changes in traffic volumes and speeds on the roadway.

2. the altered geometric configuration of the road--completely depressed, with large sections enclosed in tunnel.

Based on existing peak hour traffic volumes, and those projected for alternatives, the first of these factors will have negligible noise impact under any of the alternatives. Volumes on all links are already so high that projected volume increases amount to a relatively small percentage of the existing volumes: the largest increases projected are on the order of 25 per cent or less of existing volumes. This corresponds to an increase in noise level of less than 1 decibel--an increase only just detectable under laboratory conditions and virtually imperceptible in an urban context. This occurs if traffic speeds are kept constant as volume increases.

However, in the Artery situation, speeds are not assumed to hold constant: the improved capacity provided by the reconstruction will allow increased operating speeds on most links. Heavy trucks represent the most important component of traffic noise on the Artery. As the operating speed of trucks on a freeway increases, the L10 noise level associated with truck operations decreases. The implication for the Artery is that increased operating speeds for all traffic will cause a slight decrease in Artery-generated noise, more than sufficient to compensate for the slight increase associated with higher volumes.

The second aspect mentioned above, the altered geometric configuration of the roadway, is likely to be the more important factor in determining noise impacts of the proposed project.

In the event that the entire length of the Central Section was depressed and covered, the Artery would effectively be removed as a dominant noise source in the area it traverses, creating little direct noise impact except possibly into buildings adjacent to entrance and exit ramp locations. However, surface traffic on local streets would remain as a major source throughout the area, so that overall L10 noise levels in most locations would probably be reduced only slightly, if at all.

The most likely areawide effect of this complete depression would be some reduction in background noise levels within several blocks of the Artery in all directions. This is a mixed blessing, since the remaining

intrusive noise peaks associated with local traffic will tend to be more noticeable when the background noise is lowered.

The noise benefit likely to accompany the complete depression of the Central Section would accrue only to those residences and activites which directly abut the existing road, especially to buildings more than 2 stories high. For these locations, notably Harbor Towers and the office buildings with windows looking directly out at Artery traffic, the depression and decking over of the Artery may represent a significant noise benefit.

These abutting buildings presently provide a large degree of shielding from Artery-generated peak noise levels for structures located directly behind them. The structures beyond this first row are not likely to realize significant additional benefit (or detriment) as a result of the Artery depression.

The foregoing discussion assumes that the entire length of the Central Section will be depressed and decked over, since this would represent the "maximum change" compared with the existing situation. However, it is likely that some sections of the depressed roadway would need to be left uncovered. In this event, the abutters of the sections left uncovered would experience very little change in existing noise levels, particularly at windows up above the first several stories. Observers from these heights would retain virtual line-of-sight view of the road, and would not benefit greatly, in a noise impact sense, from the depression. Only at street level, and perhaps at the second and third floors of some buildings, might some shielding occur. The importance of this effect should be the subject of more precise analysis, once a design of the depressed roadway is developed.

Air Quality Impacts

In order to obtain a first-cut comparison of emissions burdens associated with the various Central Section alternatives, calculations of gross pollutant emissions for CO, HC and NO_x were carried out for the Central Section main line and ramps only (i.e., traffic volumes on

local streets and on other sections of the Artery were excluded). The traffic volumes used for these calculations were based on a 1975 level of demand, assuming the design changes associated with the nine alternatives; thus, the "No-Build" case is equivalent to the "Existing Gross Pollutant Emissions" presented earlier. As before, predictions of operating speeds were available for individual links; these were used to speed-correct the average emissions factors for 1975, taken from the EPA Compilation document, Supplement 5. The resulting estimated emission totals associated with all alternatives are presented in Figure 51.

Figure 51 Gross Pollutant Emissions—Central Artery (Central) Alternatives

Alternative	Pollutant Emissions tons/year CO	HC	NO_x
1—No Build	5220	570	430
2—No Build & SP	5350	580	430
3—No Build & GP	4190	550	390
4—Central only	2590	330	570
5—Central & SP	2610	360	570
6—Central & GP	2450	340	550
7—Central & South	1830	290	620
8—Central & South & SP	1910	300	620
9—Central & South & GP	1730	280	590

SP = special-purpose third harbor crossing
GP = general-purpose third harbor crossing

Variations among the alternatives may occur because of:

- differences in demand generated by each of the alternatives;
- changes in speeds from link to link according to capacity and demand (emissions of all three pollutants are speed-dependent);
- minor differences among alternatives in length of roadway, resulting in changes in overall vehicle-miles of travel even when volumes are constant.

Generally speaking, only slight variations occur for any Central Section alternative between the no-tunnel option and the inclusion of a special- or general-purpose harbor tunnel. Either of the "Central Section--Build" alternatives produces smaller quantities of CO and HC emissions than does the "No-Build" alternative. However, the "No-Build" case emerge as the most desirable of the three in terms of NO_x emissions, because of the increased operating speeds associated with the "Build" alternatives.

In the "No-Build" case, these volumes of pollutants are emitted directly into the surrounding atmosphere from the elevated highway. All of the "Build" alternatives involve depressing the entire length of the Central Section, with the major portion of the road to be enclosed in tunnel. Pollutants associated with all "Build" alternatives would be vented through surface ventilation stacks, comparable to those associated with the Dewey Square Tunnel in the South. This would divert some proportion of the total projected emissions from the present line source configuration into a number of point sources the number and location of which have not yet been suggested. Detailed analysis of concentration levels, existing and projected, at nearby sensitive sites will be required once proposed locations for ventilation stacks have been decided upon; this analysis will constitute one of the major elements of the next stage of environmental planning for this project.

Water Quality Impacts

Alternatives 1,2 and 3 will provide no change in water quality in the Central Area of the Corridor. Alternative 4 through 9 which require the construction of tunnels for the Artery will result in significant changes in the ways in which water is now collected and carried off throughout the corridor. Following construction, all alternatives will likely result in a positive impact on water quality as a consequence of roadway runoff control. Plans for the project not only fit with overall plans to improve the quality of water runoff within the Downtown area, but may provide an incentive to advance the plans for water outfall treatment and control through integrated construction of the highway and water pollution control facilities.

Costs, Construction Duration and Disruption

Project Life

All deck replacement work is anticipated to have an economic life of 30 years. All tunnel construction will have an economic life of 40 years.

Construction Costs - Central Area

Construction costs for the No-Build alternatives (1,2 and 3) are $25,800,000 in the Central Area. This includes only the costs of concrete deck replacements on the existing Artery facility in the Central Area. If additional ramp replacement work is undertaken, the cost will increase to $32,400,000. Construction costs for alternatives 4 through 9 - Reconstruction of the Central Area - are $1,015,000,000. This includes the construction of two new tunnels for the Artery and transit way between Congress Street and Causeway Street and two new bridges over the Charles River. It also includes connections into the existing facilities on the extremities of the project, and improvements to the approaches from expressways and local streets. Demolition of the existing structure is also included.

These costs are only for improvements to the Artery itself in the Central Area, and exclude related projects, such as the Third Harbor Tunnel and the North and South portions of the Artery.

Construction Costs - Related Projects

Alternative 1 - No related projects
Alternative 2 - Special Purpose Harbor Tunnel from Broadway to E. Boston: $407,940,000
Alternative 3 - General Purpose Harbor Tunnel from Broadway to E. Boston: $634,420,000
Alternative 4 - No related projects
Alternative 5 - Special Purpose Harbor Tunnel: $409,940,000
Alternative 6 - General Purpose Harbor Tunnel: $634,420,000
Alternative 7 - Reconstruction of the South Area of the Artery: $190,580,000

Alternative 8 - Reconstruction of the South Area of the Artery: $190,580,000 plus Special Purpose Harbor Tunnel: $312,760,000

Alternative 9 - Reconstruction of the South Area of the Artery: $190,580,000 plus General Purpose Harbor Tunnel: $390,720,000

Note: The construction cost estimates for the Harbor Tunnels are less if the South Area of the Artery is reconstructed, because the South Area project includes the tunnel approaches in the vicinity of Northern Avenue.

Types of Construction Disruption

Alternatives 1, 2 and 3

In order to maintain traffic on the expressways, the decks would be replaced one lane at a time. This will result in moderate to severe traffic disruption for the construction period. If ramps are reconstructed, the work will be phased jointly with deck replacement.

Alternatives 4 through 9

Reconstruction of the Artery by providing new tunnels for the roadway will result in specific disruption to traffic which will vary by phases of the project. The overall goal is to disrupt Artery traffic minimally; this will be accomplished by making replacement lanes available for existing traffic at all times throughout the construction period. Specific disruption to local streets may take place as utilities are removed or temporarily relocated to allow for tunnel construction. However, disruption to local traffic should be only temporary, as local streets are temporarily detoured during construction. Detailed design of the proposed project is essential to determine the nature of disruption and the mitigating measures which must be undertaken to modify impacts on local communities, local and expressway traffic, and on businesses throughout the corridor.

CHAPTER IV. PUBLIC PARTICIPATION

IV.A PROCESS

Public involvement has led toward the development of this document, as an integral part of the process of discussing issues and designing proposals which meet community needs. The current process began with the community concerns about the construction of transportation improvements in the area, and the subsequent study of changes to the Artery carried out through the Boston Transportation Planning Review and a subsequent study conducted by the Boston Redevelopment Authority for the Mass. Department of Public Works.

IV.B PUBLIC INVOLVEMENT PROGRAM

A slide show was developed to provide information to the public on the overall program for proposed improvements to the Artery corridor and to generate comment from concerned citizens. The slide show has been presented to interested community groups and individuals, public agencies and responsible officials, and organizations with regional focus.

A working committee of local and regional interests was established to review the proposed improvements to the Artery corridor. A list of representatives from the Central Area was developed and is now included on all mailings, literature distributions, and invitations to the working committee and other public meetings.

In addition to the slide show and working committee meetings, special briefings have been held with specific interests in proposed Central Area improvements. They include Boston city officials, property owners, private organizations, and agencies which have an interest in the area, such as the Mass. Turnpike Authority.

Through the above activities, this draft Corridor Planning Study has been prepared for the Central Area. This document was distributed to key community representatives, discussed in briefings, distributed to regional organizations and public agencies and was the subject of a working committee meeting on January 9,

1978. Comments resulting from meetings have been incorporated into this chapter and other parts of this document. A detailed listing of comments is included in this chapter.

North Station Merchants - Nov. 28, 1977

A small meeting was held with several merchants with operations in the vicinity of North Station to discuss the Corridor Planning Study. The document was reviewed in outline form, and questions followed. These questions included:

1. The timing of the study for the Central Area, vs. work to be done on the North Area.

2. Potential takings of properties in the vicinity of North Station.

3. Replacement of the Green Line Elevated transit facility as a related project or as an integral part of Artery work.

4. Revisions to commuter rail facilities as part of the overall plan.

5. The division between work in the North Area and the Central Area, especially the new crossing of the Charles River.

6. Potential disruption during construction.

Greater Boston Chamber of Commerce - Dec. 19, 1977

Because the Transportation Committee of the Chamber of Commerce is in transition between Chairperson, it was decided to hold the meeting with the former committee chairman - Mr. Thompson and the present Executive Director of the Chamber - Mr. Chouinard. Principal concerns:

1. The relationship between the third harbor crossing proposal and the Central Artery studies.

2. The extent of environmental analysis to be considered for the third harbor crossing proposal in conjunction with Central Artery studies.

3. The timing of the study effort - dates of beginning consultant activities, dates of decision.

4. The extent of community involvement including business people in the study process.

5. Buildings which might be taken as part of the construction process.

6. The extent to which disruptive effects of construction will be studied as part of the overall process of examining the proposals.

Boston Harbor Associates - January 4, 1978

A joint meeting of representatives of several local groups was held to discuss the project and to raise questions for the Central Artery staff. People called together were from the Boston Harbor Associates, Waterfront Neighborhood Association League of Women Voters and the Sierra Club. The questions raised by these people were submitted in written form and are listed below in the form presented.

1. Will it be possible to have regular participatory meetings where citizens can be involved in the process, as in the Orange and Red Line projects?

2. What sort of energy conservation goals, in terms of traffic into the central city, are being established for the long term in Boston? We are concerned about the implications, for example, of the Clean Air Act, as well as projections of diminishings fuels.

3. In light of a future, which is still difficult to imagine, could the next phase of the study include a "radical alternative," which would reflect energy conservation goals and appeal to a reduction in traffic through the central city, at least by conventional vehicles?

4. Could you demonstrate the need for a Transit Corridor between the North and South Stations in terms of incremental cost and numbers to be served vs. a circulatory bus route to distribute passengers to Park Square, Government Center, business district, etc.?

5. Can the Fort Point Channel area be studied as a discrete area in need of special attention as the remaining water edge of the city of Boston, worthy of aesthetic consideration given the increasing pedestrian uses in the area related to the South Station renewal, Federal Reserve Bank, Wharf Museum, and others?

6. Where is the Northern Avenue Bridge construction project now? How will it tie in with the depressed Artery?

7. Can a ferry for passengers and vehicles be studied as an alternative to the new harbor tunnel crossing? If a new crossing is established, do we need the Sumner and Callahan Tunnels?

8. Who will be responsible for surface uses? (Note: p. 113, Tax Base and Development Impacts "new buildings on parcels created within the highway right-of-way, above the new tunnels.") Will there be height restrictions?

9. We are concerned about the possibility that some sections would be left open (p. 116 - "it is likely that some sections of the depressed roadway would need to be left uncovered ."). Is there a commitment to decking the Artery?

10. How will current plans for major public investments in sewer reconstruction be integrated with the reconstruction of the Central Artery? Please elaborate meaning of "may provide an incentive to advance the plans for water outfall treatment and control through integrated construction of the highway and water pollution control facilities." (p. 119)

11. How will planning for the seaport access road in South Boston be integrated with the Central Artery?

Central Artery Working Committee - January 9, 1978

First items of business were a progress report on the recent activities of the Artery staff followed by a discussion of the Central Artery Corridor Planning Study. Questions raised by the joint group of members of the Waterfront Neighborhood Association, League of Women Voters, the Sierra Club, and the Boston Harbor Associates served as the basis for discussion of the planning study. These questions are listed above.

In addition to the discussion of the questions raised by these groups, the following points were raised:

1. The study is heavily oriented toward only transportation improvements, whereas the potential surface improvements and environmental benefits are major ingredients

of the proposal, and reasons why the community has supported the proposed improvements.

2. The kinds of alternatives which can be considered in the period of preparation of the EIS, and in particular, will the alternative of taking down the Artery be examined.

3. Is the placement of a new park on the roof of a tunnel considered a physical impact?

There was a discussion of the kinds of alternatives which would be considered in the preparation of the EIS, including the possibility of taking the Artery down, and not replacing it with a new facility. Transit options were also discussed as a means of replacing the demand for the roadway. It was emphasized that the transit link was of great interest to residents of the corridor and that it deserved detailed study. The staff indicated that the mode for the transit link has not been determined and that it would be included in the EIS work as a major work element. The potential of carrying the transit link into Charlestown was also suggested as a major item for exploration.

The Fort Point Channel was discussed, even though it is a part of the South area of the Corridor. The location of the new tunnel under Dorchester Avenue vs. being in the Channel was discussed. There was a major question raised of whether or not the new tunnel could be entirely under water in the Channel, or whether it would at certain locations be visible on the surface. The retention of the channel intact without physical changes which are visible was mentioned. In response, another individual asked if the park was visible, would that become a major physical impact on the Channel - one which would be considered a negative impact.

Sewage outfalls in the Fort Point Channel was discussed and the question was raised of the use of highway funding to improve the water quality of the Channel. The Northern Avenue Bridge and its relation to the project was also mentioned.

The possibility of a ferry was discussed, including the question of whether or not it could serve as an alternative to the Third Harbor Crossing or the present tunnels. The brief discussion which followed centered on the possibility of including work on the Third Harbor Crossing in the Artery discussion. The new tunnel will not be examined in detail as part of the Artery Study, except for traffic impacts. Therefore, questions of the ferry alternative should be included in ultimate more detailed studies of the new harbor tunnel. Similarly, questions of Blue Line extensions into the Airport are also more related to the tunnel than to the Artery.

The question of equity in the proposed improvements was raised. If the larger issues of ultimate road use, energy efficiency and mode split are not analyzed at the level of the Corridor Planning Study, will they be raised elsewhere.

A strong feeling against the proposed arterial road on the surface above the depressed Artery was expressed. The maximum possibility for new uses should be explored, including not providing a new surface arterial. A commitment to maximum decking above the Artery should be made.

The question was raised of the extent of the control which the community would have when the Artery was depressed. In response, it was stated that institutional arrangements for development of land use controls would be worked out in the course of the EIS.

Back Bay - Beacon Hill Community Review - January 13, 1978

A meeting of representatives from the Back Bay and Beacon Hill neighborhood associations was called by the Little City Hall Manager for both areas - Jim Shevln. In addition to Mr. Shevlin, Charles Rogers from Beacon Hill and Norris Strawbridge from Back Bay were present. The questions raised were as follows:

1. Back Bay is being strongly impacted by access onto Berkeley Street both from Storrow Drive and from the South End. Can this situation be improved?

2. The possible improvements to the Artery will impact Storrow Drive, at Leverett Circle. Can the improvements be extended or at least studied as far as Arlington Street?

3. Impacts of the Artery proposals should be studied for Beacon, Arlington and Berkeley Streets and for Commonwealth Avenue.

4. Proposals for the improvement of Charles Circle should be examined for potential relationship to Artery proposals.

5. Access to the Sumner and Callahan Tunnels via local streets should be discouraged.

6. There should be no widening of Storrow Drive.

7. There should be consideration of construction impacts on local streets in the area.

North End Businessman's Association - March 29, 1977

This was a meeting to present the Central Artery slide show to business people in the North End and in the pushcart area. It was emphasized that the local business community caters to the needs of the residents as well as a large number of people in the metropolitan area. It depends upon adequate traffic circulation and off-street parking. The recent impact on traffic circulation around Quincy Markets has had a detrimental effect upon the local merchants. The lack of commercial parking in the North End and the reluctance of shoppers to use parking facilities around the periphery of the community has caused some conflicts between the residents, commuters and shoppers.

The business community is as important to the viability of the future of the North End as is the residential. All precautions must be taken during the formulation of the Environmental Impact Statement to address the views and values of local merchants. The Central Artery supplies the community with many off-street parking slots. What will happen to this parking during and after any reconstruction is of vital importance. A good traffic management scheme must incorporate local recommendations.

The main concerns discussed were:

1. What role will the business community play in the Environmental Impact Statement?

2. The possibilities are real that the public officials working on the Environmental Impact Statement might change with elections over the next six years. What guarantee do we have that agreements will be adhered to?

3. A comprehensive traffic management scheme is paramount for not only the delivery of goods, but also the movement of cross-town traffic.

4. Utility construction is difficult for the community to monitor. The city and state regulatory agencies do not apply proper enforcement on safeguards for communities. If the Artery depression alternative is a viable project, then a major utility relocation program will get underway. A new code for utility construction within urban areas must be adopted and enforced.

5. What role can the small merchants play in the development of any land generated by the depression alternative?

6. Where will the construction staging be located along the corridor?

7. What economic benefits - such as jobs and business opportunities will be available to local merchants?

North End Health Center - November, 1977

At a meeting with the North End Health Center, the following questions and comments were raised:

1. Aesthetics of the Artery are a concern.

2. Will all traffic figures and projections be made available to the community? Will all routes for traffic during construction be outlined and agreed upon before proceeding with any alternative?

3. Noise and vibration impacts can have a detrimental affect on one's nervous system. These concerns must be addressed during the Environmental Impact Statement.

4. The community perceives a lack of controls the state has upon contractors performing work for them. What guarantees will be made that this work will proceed based on what was agreed by the community and state agencies.

5. What role will the City of Boston play in this project?

6. Will any money be available for community programs dealing with human impacts of reconstruction?

7. Will emergency vehicles such as fire, police and ambulances have flexibility of movement within the community during any reconstruction?

8. Will existing water and sewer lines within the community be affected?

Knights Of Columbus - Elderly Housing Developments - November 1 & 15, 1977

The meeting with this group produced questions and comments listed below.

The main concerns are:

1. The impact of utility relocation and construction on the elderly tenants.

2. Who would represent elderly concerns in the Environmental Impact Statement?

3. Would there be any constraints on pedestrian access to the downtown and market area?

4. If depression of the Artery were technically and environmentally feasible, would construction take place on a twenty-four hour basis?

5. Which construction alternative would have the least impact on the new elderly structures?

6. All major pedestrian routes must be traversable by elderly and handicapped. Advanced notification of the discontinuance and relocation of pedestrian paths during construction is mandatory.

7. Will the families of the elderly who are living outside the North End have access in visiting during reconstruction?

8. Wouldn't local residents be asked to suffer through construction, but not reap the benefits of any reconstruction?

San Marco Housing Condominiums - November 10, 1977

Development of sixty condominiums will be completed in 1979. The management would like a working committee formulated for residents to work on the Environmental Impact Statement.

1. Are these residents considered as a North End or Waterfront voice in the Environmental Impact Statement?

2. The buildings have a structural problem that can be directly attributed to the movement of the water table during construction of the Callahan Tunnel. What guarantee will they have that this will not happen again if tunneling for a depression were a viable solution to the transportation problems of the area?

3. What effect would this process have on any potential development on the Boston Redevelopment Authority's parcel adjacent to their development and the Artery?

4. What are the controls, if any, on undesirable development of any land generated by the depression alternative?

5. Who will address the water table program?

6. What about noise impacts?

North End Task Force - November 28, 1977

The Corridor Planning Study was presented and discussed in detail. Task force members were requested to review it and send along any comments. To date, no correspondence has been received regarding this matter.

North End Athletics Program - December 1 and 15, 1977

Questions raised during the meeting were as follows:

1. If the Artery is depressed, will it maintain the same entrance and exits? If so, the project will not have any impact on lowering traffic volumes in the North End.

2. If construction of the north section of the Artery begins next year, won't this compound the parking problems on North End streets, especially during Boston Garden events?

3. Will commitments on summer jobs be made available to North End youth during any construction? Will the state document these commitments?

4. Will this project encompass any residential building taking?

5. Whom does the community depend upon in enforcing traffic restrictions during any construction, the Boston Police, State Police or M.D.C. Police?

6. Will teenagers be allowed to participate in the Environmental Impact Statement? Will the state and city officials listen to their needs? If we are to survive as a community over the next twenty years, opportunities must be made available to our youth.

7. What controls does the community have regarding the development of land? Will the Environmental Impact Statement include an evaluation of new schools, gymnasium, indoor track facility, and tennis courts for our children?

Mercantile Wharf Building - December 1 and 23, 1977

The main concerns were:

1. There are presently some structural problems with the building; how would reconstruction affect them?

2. There are approximately 125 units in the building, the residents have an association. Would their association have a voice in the Environmental Impact Statement?

3. What would be the reuse of any land generated by the depression alternative? The residents are worried about more development generating liquor licenses, they have had a long and difficult battle with the cafe in their building.

4. Would there be an adequate traffic-management scheme incorporating their concerns? The North End waterfront has had serious parking problems over the last decade; there is a lack of residential parking. How will reconstruction affect this parking problem?

5. Where would the contractors working on the artery store their materials and equipment? Could it be left off their streets?

6. Presently the residents notice an increase in traffic congestion. Wouldn't the reconstruction increase that problem?

7. Would a connection on the proposed rail link between North Station and South Station be located in close proximity to their building? If so, would the connector have ingress and egress points on the opposite side of the Artery facing Quincy Market and Government Center?

Saint Anthony's Association - December 9, 1977

1. When will construction on the North section begin? Will residents have any input in that section?

2. Who will address the impact on parking in the North Station, North Washington Street, Endicott Street area when north section begins?

3. In the central section, what role will the North End community have?

4. How can utilities be relocated without interfering with electric, gas, water and sewer services in the community?

5. What about high pressure water service for fire fighting purposes during construction?

6. What are the controls to prevent the state changing its policy on land and building takings midway through the project?

7. Won't the North End streets become more inviting to commuters travelling between North Station and South Station during utility relocation and construction, thereby compounding traffic problems?

8. If the community says "no" to any alternative, and state, city and neighboring communities say "yes", whom will the federal government listen to?

North End Neighborhood Association - February 2, 1978

Questions raised:

1. Who will participate in the formulation of an Environmental Impact Statement with regard to the central section?

2. If the depression alternative is feasible, would any land generated by such a project be suitable for housing?

3. Will state and federal governments create subsidy programs for residents in order to develop new housing?

4. Presently the community is subjected to noise and air pollution from the tunnel ventilation buildings. Wouldn't similar ventilation buildings be needed within the depressed corridor?

5. What other communities are involved in the central section?

6. How many government agencies will be participating?

7. Will the North End be subjected to traffic impacts when the north section is depressed?

8. If the depression alternative went ahead, would there be any open trenches during construction?

North End General Comments

The Central Area Planning Study seems to adequately fulfill its purpose of providing a summary of engineering and environmental considerations, and provides what appears to be the logical conclusions and recommendations for further study of certain alternatives of reconstructing or improving the Central Artery.

Over the past few month meetings have been held with about 100 individual community residents, business people, and clergy to discuss the formulation of the Environmental Impact Statement and gather responses to the Corridor Study.

The following questions are an overview of their concerns:

1. What is the scope of citizen participation?

2. Who will participate in the Environmental Impact Statement -which State agencies, city agencies, community groups, businessmen?

3. What will be the format of the meetings?

4. What powers does the community have, if any? Veto? Advisory? Will their input be meaningful?

5. Whom can the community appeal to if their views and values are not adhered to?

6. Will the North End - Waterfront groups have separate or equal billing?

7. What role will business people play? Traffic management schemes must address their concerns.

8. Will the process involve the social effects of the project, such as housing costs, families relocating because of construction, businesses relocating or closing because of impact of construction on parking and traffic circulation?

9. How will maximum economic benefits - such as jobs and business opportunities be made available to the community?

10. Will the process discuss improvements of pedestrian connectors along Sumner - Callahan Tunnels, Cross Street, North Station and Quincy Markets?

The issue of the Central Artery is important to the North End, and its impacts will be crucial in determining the future of that neighborhood.

Legislative Contacts

This document was presented to the members of the Joint Legislative Committee on Transportation for review and comment. Staff briefings were arranged and the members of the Joint Committee and supporting staff people have been informed of its progress. Representatives and Senators from those districts most affected have also been contacted.

CHAPTER V. CONCLUSIONS & RECOMMENDATIONS

Improvements to portions of the Central Area of the Artery Corridor will have to be undertaken within the near future. These improvements are principally deck replacements on the expressway throughout the corridor. These decks are deteriorating and will need replacement if no other work is undertaken in the corridor. However, there are substantial problems in the operations of the present facility which should be examined to determine the appropriate course of action.

Operational problems of the present facility in the Central Area must be solved within the present corridor. There are no feasible alternatives to the present corridor in which a new or bypass facility can be located. Alternatives to the present corridor have been examined for all alignments which have been discussed in past or present contexts; none of the alternative corridors provides a feasible location for a new facility.

Within the present corridor, there are few alternatives which improve operations of the Central Area of the Artery without extensive negative environmental impacts. Widening the full length of the present highway, for example, is not an acceptable solution from a community or land damage viewpoint. Double-decking the facility is also unacceptable. Existing land uses and proposed new developments constrain alternative locations for improvements. Two basic alternatives have emerged: the no-build which provides for upgrading the present facility; and a reconstruction which includes a new facility in tunnels to replace the existing highway in the Central Area, plus two new low-level bridges over the Charles River These two basic alternatives have been examined in detail particularly with respect to

their relationship to projects external to the Central Area; i.e., the proposed improvements to the South Area of the Artery Corridor, and a proposed Third Harbor Tunnel, for either general or specific purpose use. This analysis led to the examination of nine possible alternatives.

Feasible Alternatives for Central Area

The chart below shows the alternative permutations which are possible in the Central Area of the Artery Corridor. Alternative 1 is the basic no-build Alternative with Alternatives 2 and 3 as permutations. Alternative 4 is the basic reconstruction alternative with alternatives 5,6,7,8 and 9 as permutations.

Figure 52 Central Area Alternatives

	Without 3rd Harbor Tunnel	With 3rd Harbor Tunnel	
		Special Purpose	General Purpose
No Build	Alt. 1	Alt. 2	Alt. 3
Reconstruction Without South Area With Transitway	Alt. 4	Alt. 5	Alt. 6
Reconstruction With South Area With Transitway	Alt. 7	Alt. 8	Alt. 9

The No-Build Alternatives

Alternative 1, with deck replacement and possibly ramps modification as its major features, has two variations - Alternatives 2 and 3- which include deck replacement in combination with previously developed alignments for a third harbor tunnel project. Alternatives 2 and 3 were examined because: 1. previous alternatives for a third harbor tunnel required study in relation to more current thinking about improvements in the Central Area; 2. these alternatives are useful analytically for

comparing Artery improvements with an independently-built Third Harbor Tunnel. Previous studies of a Third Harbor Tunnel identified the Fort Point Channel as the most feasible location for such a facility. However, use of the Channel for an independent Third Harbor Tunnel, as in no-build alternatives 2 and 3 (and reconstruction alternatives 5 and 6 discussed below), would foreclose South Area Artery improvements in that alignment. The independent Third Harbor Tunnel has benefits for traffic which are different from those obtained by Artery improvements. Current analysis shows that the Fort Point Channel can be used for Artery improvements while at the same time preserving the option for a separately built, but physically connected Third Harbor Tunnel. The costs for either an independent Third Harbor Tunnel or one connected with South Area Artery improvements are approximately the same. Because Alternatives 2 and 3 do not physically improve the Central Area Area of the Artery, and because they foreclose options for the South Area of the Artery, they should be dropped from further consideration as major alternatives. Alternative 1 should be carried into further environmental and engineering analysis.

Reconstruction Alternatives

Alternatives 4 through 9 represent the various possibilities of a full reconstruction of the Central Area for Artery improvements. Alternative 4 is the basic alternative for reconstruction; Alternatives 5 through 9 are permutations which have been included to afford a basis for analysis of the reconstruction as it might relate to subsequent or consurrent related projects. Analysis of Alternative 4 has shown that it is possible to construct a new facility which would improve the transportation operations of the Central Area and which would be compatible with concurrent or subsequent development of related projects. This includes a later addition of a Third Harbor Tunnel. However, the Third Harbor Tunnel will not by itself preclude the need for Artery improvements. Alternatives 5 and 6 use the Fort Point Channel for an independent Third Harbor Tunnel, which would foreclose South Area Artery improvements in that alignment (as would alternatives 2 and 3 as discussed above). For this reason and others cited in the discussion of Alternatives 2 and 3, Alternatives 5 and 6 should be dropped from further consideration. South Area Artery improvements are included in Alternative 7. Because of the potential interactions between Central Area Artery improvements and other projects, it is recommended that Alternatives 4 and 7 be carried into further environmental and engineering analysis.

It should be noted that the construction of a Third Harbor Tunnel is a separate project, serving purposes and having benefits which are different from the reconstruction of the Central Area of the Artery Corridor. The difference in benefits between reconstruction alternatives and the Third Harbor Tunnel may be summarized as follows. The reconstruction affords operational improvements by: provision of three lanes in each direction, with a shoulder in each direction used in peak periods; an additional transitional lane in each direction in areas such as the interchange between Storrow Drive and the Sumner-Callahan Tunnels; fully grade separated interchange between the Sumner-Callahan Tunnels and the Artery; fewer ramps to and from the Artery, with better spacing between ramps; provision of speed change lanes for ramp traffic; surface frontage roads above the Artery for collection and distribution of local traffic; and land for development on the decks over the tunneled Artery. None of these improvements can be effected through the construction of the Third Harbor Tunnel nor is the Tunnel a prerequisite to necessary improvements on the Artery. Therefore, alternatives 8 and 9 should also be dropped from further environmental and engineering studies in connection with the Central Artery. The alternatives which have been developed for the Central Area, and which should be carried forward (Alternatives 1, 4 and 7) have inherent flexibility to accommodate the Third Harbor Tunnel while serving Central Area needs.

Anticipated Federal Funding Participation

I-93 is the principal North-South route connecting, in the north, the Boston Metropolitan Area to the Merrimac Valley (Lowell and Lawrence), New Hampshire, Vermont and Canada. To the south, it connects the Metropolitan Area to the southeast area of the Commonwealth, Cape Cod, Rhode Island, and the eastern seaboard. I-90, the Massachusetts Turnpike, a toll facility, connects the Metropolitan Area with the western Massachusetts metropolitan area of Worcester and Springfield, New York State, and states west of New York. Traffic problems associated with the interchange of these two roadways are documented in this report. Volumes of traffic on I-93 approximate 135,000 ADT; all connecting

expressways - I-93 north and south, Storrow Drive and the Harbor Tunnels - exceed 60,000 ADT.

Certain alternatives described in this document would require the addition, removal and/or realignment of certain ramp connections between these two major interstate routes. Replacement "in-kind" is anticipated.

Any federal-aided highway is subject to the requirement in Section 301 of Title 23, United States Code, Highways, that it be free from tolls (except for certain toll bridges and tunnels as provided in Section 129). This requirement is met. There is no intention of imposing tolls on I-93, nor are motorists using I-93 required to exit through the I-90 tolls. A large portion of I-93 traffic is not interchanging with the connecting expressways. While the expressway connection provides major transfers of traffic between facilities, I-93 as part of the interstate system is an essential through route and the major highway in the City of Boston. As long as the present facility is not improved, motorists on I-93 will continue to experience severe traffic problems from operational and safety viewpoints.

If certain alternatives described were wholly improvements for an approach to or from a toll facility, then that particular alternative would not be eligible for federal participation. This is not the case here.

The improvements described in all alternatives are mainly to improve traffic operational conditions on I-93, not on connecting expressways. In view of this, it is the opinion of the Department of Public Works that the formula for funding the chosen alternative be on an Interstate 90:10 basis.

Conclusions

1. If reconstruction is not undertaken, work will have to be done on the Central Area of the Artery Corridor between 1984 and 1989, 5-10 to replace the existing

decks in order that the Artery can continue to function.

2. Given the scale of disruption which would accompany the replacement of the decks in the Central Area of the Artery, consideration must be given to alternates which would address the functional problems of the Artery as well as the potential disruption from construction.

3. There are no feasible alternatives outside the present Artery Corridor which are suitable corridors for permanent new facilities.

4. A series of alternatives within the Artery Corridor have been examined. A number are unacceptable: double-decking the present elevated Artery facility; widening the full length of the Artery; tunneling for one directional movement.

5. A number of alternatives appear to be feasible. (See Figure 52) Of these alternatives, some appear to offer substantially greater potential than others to address the transportation and construction problems of the Artery.

6. Alternatives which should not receive any further examination are Alternatives 2, 3, 5, 6, 8 and 9.

7. Alternatives 1, 4, and 7 should be studied in further detail.

8. Major reconstruction of the Central Area of the Artery offers the possibility of implementing a long-range strategy for the improvement of the economic future of Downtown Boston.

9. The Third Harbor Tunnel serves purposes and has benefits that are different from reconstruction of the Central Artery. All Central Area alternatives - other than the no build (Alternative 1) - should be designed to accommodate the Harbor Tunnel as a future project, and it should be retained as part of the long-range plan. Future network analyses of the Artery project should include both build and no build options of the Third Harbor

Tunnel. However, detailed study of design, costs and impacts of the Third Harbor Tunnel should proceed separately from the Artery project.

10. Questions which should receive special attention during analysis of remaining alternatives are as follows:

    a. All alternatives require detailed analysis of:

        - construction techniques and phasing
        - traffic control during construction
        - transportation service
        - demand/capacity analysis
        - surface street impacts
        - relation to harbor crossing demand and airport service
        - safety during and after construction
        - air, noise and water quality impacts
        - economic impacts (regional and local) during and after construction
        - social impacts to adjacent neighborhoods and the region, during and after construction
        - land use and urban design considerations
        - detailed cost estimates
        - employment generation

    b. Reconstruction alternatives require, in addition, detailed analysis of:

        - ventilation requirements
        - joint development and overbuilding opportunities
        - decking requirements
        - tunneling requirements
        - dangerous cargo handling
        - joint rail line construction
        - rail line service, space requirements

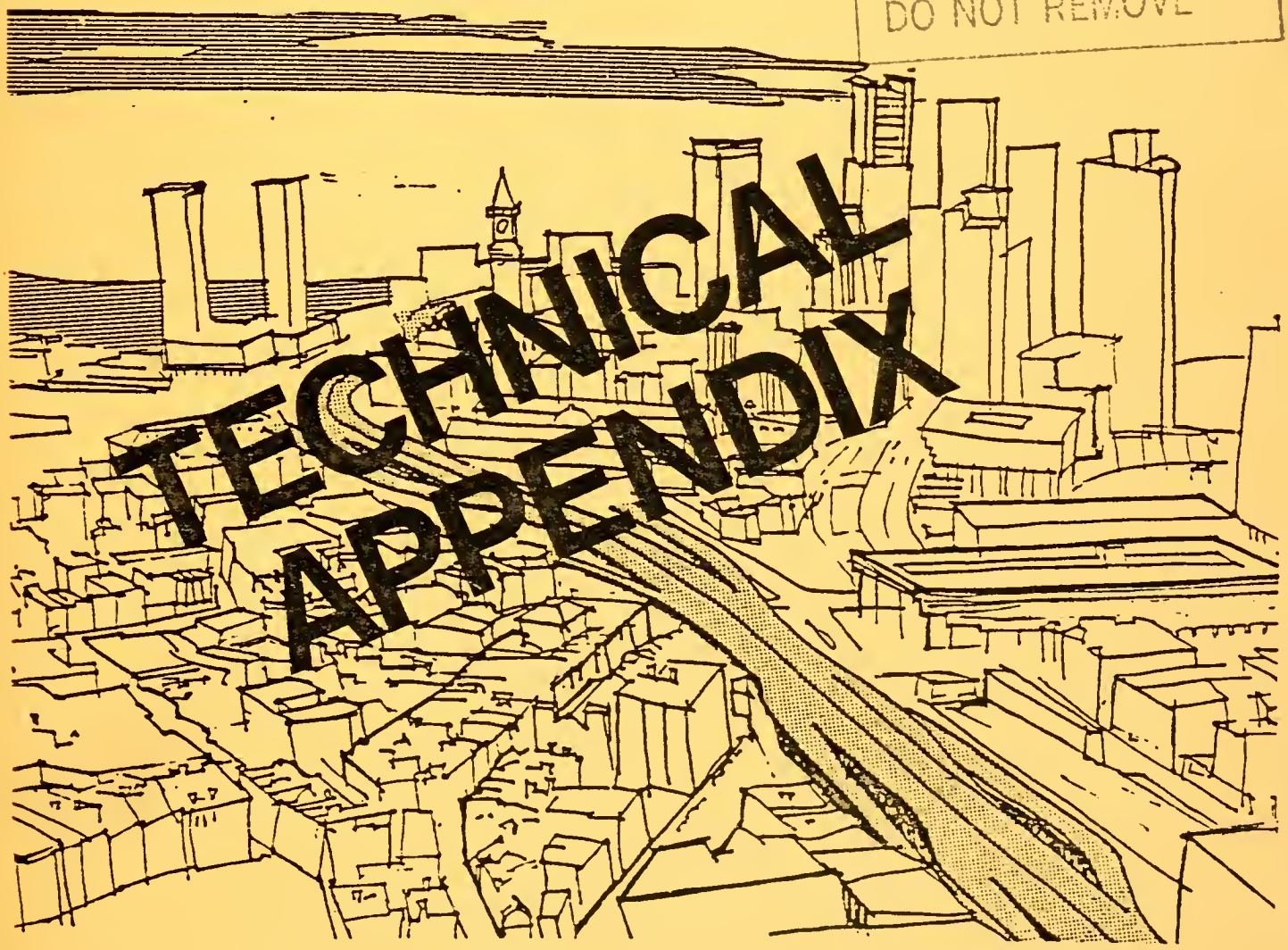
LA
83
.A88
J

CENTRAL ARTERY/I-93 CORRIDOR

CENTRAL AREA PLANNING STUDY

"BOSTON PUBLIC LIBRARY"

DIRECTOR'S OFFICE
FILE COPY
DO NOT REMOVE



BOSTON, MASS. AUGUST 1978

DIRECTOR'S OFFICE
FILE COPY
DO NOT REMOVE

I. INTRODUCTION

The following material provices technical backup on the approach and methods used in analyzing benefits, impacts, and costs for alternative Central Area Central Artery improvements considered in the Central Artery/I-93 Corridor: Central Area Planning Study. As in the Study, four areas of impact analysis are considered: operational improvements and benefits, design standards and safety, environmental and community impacts,and construction costs and impacts. Each of these is considered with regard to the various construction options developed in the Study. In some cases, methods of analysis have been taken up fully in the Study, and require little further treatment here. In others, it was appropriate that analysis details be reserved for this document. The methods used are consistent with the "state of the art" in highway planning practice. Sometimes they are qualitative, and sometimes quantitative, depending on suitability as related to the particular impact category being assessed. Also, in analyzing benefits, a conservative approach has been taken to assure that results would not overstate the worth of proposed investments. Finally, it should be noted that the analyses are at this point approximate. While the methods used have probably yielded results of the proper general ordering and magnitude, certain results can be expected to change somewhat as improved data become available and future detailed studies are undertaken.

For convenience, each of the construction options considered is described briefly below:

Alternative 1.

The No Build Alternative would retain the existing elevated facility, with possible modifications to it. This facility, which was built during 1954-1959, will require deck replacement by 1984-1989 to correct deterioration caused by annual applications of salt for snow removal, and thirty years of heavy traffic. Modifications could include selective widening of the Artery and/or rebuilding of ramps.

Alternative 2.

Alternative 2 is the same as Alternative 1 in the Central Area of the Artery, but it would include, in addition, a special purpose tunnel across the harbor to Logan Airport.

Alternative 3.

Alternative 3 is also the same as Alternative 1 in the Central Area, but it would include a general purpose tunnel to the Airport rather than one for special purposes only.

Alternative 4.

In Alternative 4, reconstruction of the Central Area of the Artery would be undertaken to maximize transportation and environmental improvements in the Area. Alternative 4 would construct a tunnel within the existing Central Artery right-of-way. The tunnel would accommodate the highway, along with a transit facility between North and South Stations.

Alternative 5.

Alternative 5 is the same as Alternative 4, with the addition of a special purpose Third Harbor Tunnel to Logan Airport.

Alternative 6.

Alternative 6 also includes the same construction in the Central Area as Alternative 4, but the Third Harbor Tunnel to Logan Airport would be constructed as a general purpose facility.

Alternative 7.

In this alternative, the Central Area would also be reconstructed as in Alternative 4, with an underground highway facility in the Central Area. In addition, however, it would also involve improvements in the South Area, including a new Atlantic Avenue or Fort Point Channel tunnel.

Alternative 8.

Alternative 8 is the same as Alternative 7, with the addition of a special purpose Third Harbor Tunnel to the Airport.

Alternative 9.

Alternative 9 is also the same as Alternative 7, except that the Third Harbor Tunnel would be for general traffic.

II. OPERATIONAL IMPROVEMENTS AND BENEFITS

The assessment of operational impacts usually involves an iterative procedure which relates traffic volumes, design characteristics, and

resulting travel characteristics and benefits. Basic travel estimation was carried out through a manual traffic assignment procedure which utilized 1975 traffic volumes, alternative system characteristics, and various assumptions regarding sources and flows of future traffic. Explicit analyses of delays and vehicle speeds were then undertaken based on traffic estimates and design characteristics of the different construction options. Travel time and operating cost savings were then calculated based on projected delays and vehicle speeds. Each of these analyses is considered below.

A. Traffic Estimation

The first step in estimating traffic was to build a base case network for the No Build Alternative. This network included the present express highway facilities in the South and Central areas, and the surrounding highways and local streets that could experience traffic impacts from South and Central Area Artery improvements. Once this was completed, 1975 traffic volumes were assigned to the major links of the network. Since this process was completed before the data became available from the Central Artery Origin/Destination survey of March, 1977, the best pre-existing available data were used. Both MDPW Automatic Traffic Recorder counts for the Central Artery and its on and off ramps, and manual traffic counts from the City of Boston Department of Traffic and Parking were used to determine the 7-9 AM and 4-6 PM peak period volumes for the No Build alternative. Manual adjustments were made to balance traffic flows for internal consistency, and checks were made for reasonableness. Traffic volume data ranged from 1972 to 1977 derived from various sources. Traffic counts made by the Massachusetts Turnpike Authority and the Boston Redevelopment Authority for special projects were used to work out the final set of 1975 assigned total peak period volumes. Truck volumes were determined from the Southeast Expressway Downtown Express Lane evaluation program.

In assigning traffic to new or improved facilities for the eight build alternatives, the following assumptions were made:

- Increased traffic volumes would occur as a result of route switching and new trips.
- Most of the "new" trips would be through trips (approximately 75%).
- An implied travel time elasticity of -1.2

was used to estimate increased travel based on travel time reductions. Assuming South Area construction but no Central Area project, this resulted in an extra 300 trips in each direction during each of the peak periods. If the Central Area were built in addition to the South Area, this resulted in an extra 500 trips in each direction during each peak period.

- The reduction in total numbers of ramps in the various alternatives was not assumed to reduce the number of trips. These on and off moves were shifted to different ramps on the Artery. It was assumed that improved service levels on the Artery would retain these trips.

- Approximately 100 trips each peak period were assigned to switch from Storrow Drive to the Massachusetts Turnpike due to a new Third Harbor Tunnel for the general purpose option only.

- Route diversion to the improved Artery would occur only from directly parallel routes such as the existing surface streets. Diversion to the improved Artery would be approximately 25% to 33% of existing off-Artery trips on these routes.

- The Third Harbor Tunnel was assumed to carry traffic only between Logan Airport and the southern and western corridors. As a special purpose facility, it was assumed to carry buses, limousines, taxis, trucks, carpools (three or more occupants per vehicle), and vanpools.

- Truck traffic was assumed to be 3.5% of total traffic in the Central Area.

The actual traffic assignment procedure for different alternatives was as follows: First, all base case traffic was assigned to each alternative, changing only the ramp volumes to reflect the different ramp locations. Second, estimates were made of traffic diverted from parallel roadways. These estimates were based on increased Artery and ramp speeds associated with the improved Artery levels of service that each alternative would allow. As part of this step, ramp volumes were changed accordingly. In the third step, new or induced trips were estimated and added to the totals on the Artery. As in Step 2, the new traffic was estimated based on the increased speeds allowed by the proposed new construction.

Again, ramp volumes were changed appropriately. The fourth step was to check the final results by computing volume/capacity ratios, and determining whether the Artery and ramp speeds assumed in the second and third steps could be maintained. If not, volumes on the Artery were adjusted downward, and traffic was rediverted onto parallel streets until the assumed speeds could be met.

The entire procedure was completed manually for Alternatives 4, 5, 6, 7 and 9. Alternative 1 (No Build) was, of course, also done as the base case. Artery traffic estimates for Alternatives 2, 3, and 8 were interpolated from numbers for the other alternatives.

B. Vehicle Speeds and Delays

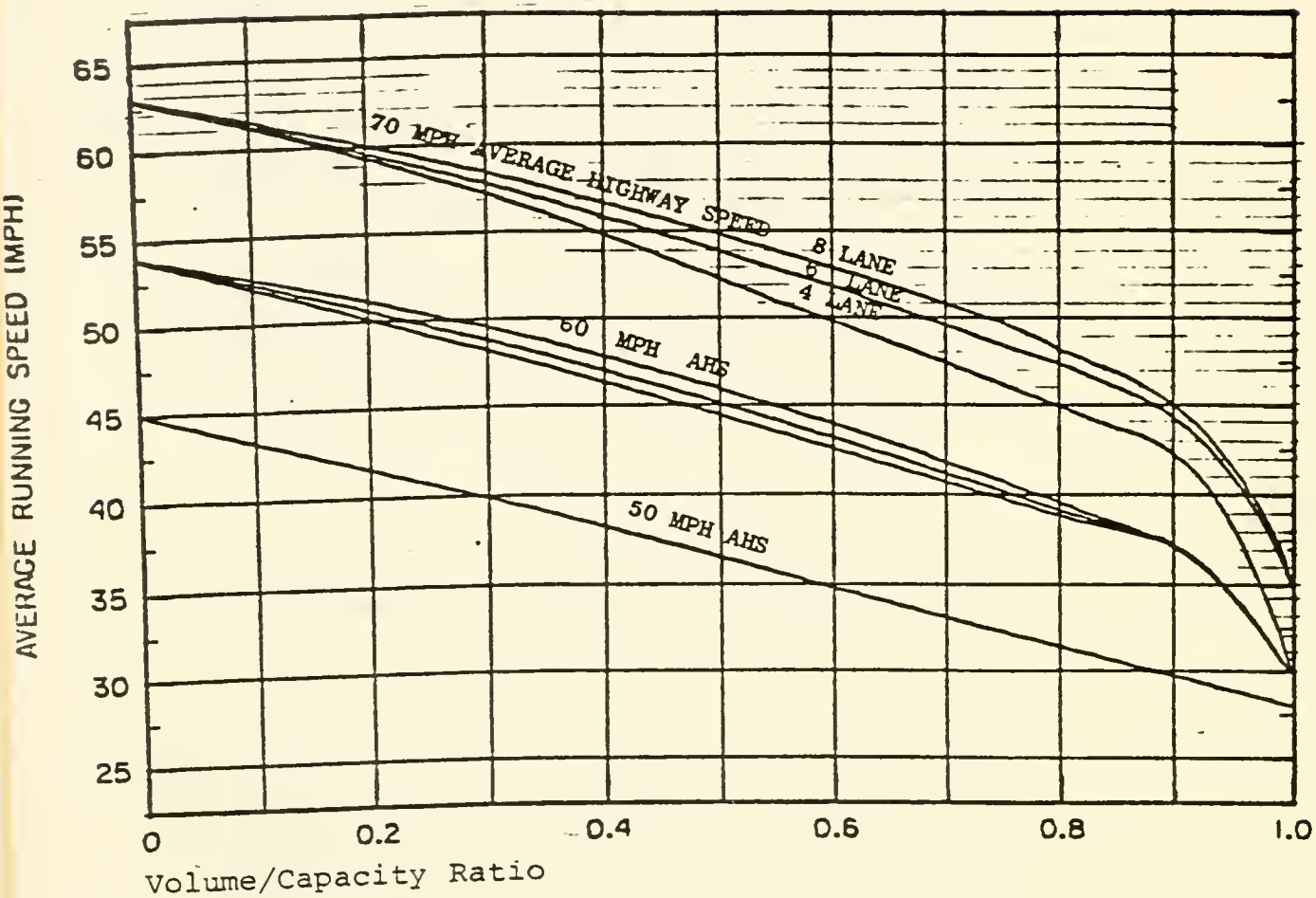
In order to calculate vehicle speeds and delays for different alternatives it is necessary to compare capacity with demand. In the Central Area analysis, the procedure for determining vehicle speeds was drawn largely from NCHRP Report #133, by Curry and Anderson.[1] Peak period demand from the traffic assignments was compared with capacities of the different highway segments, and resultant speeds were determined from Curry and Anderson as a function of Volume/Capacity ratios (see Figure 1). The curve in the figure for 50 MPH (average highway speed or design speed) was used. To complete the speed analysis, Central Area vehicle speeds for each alternative were determined by averaging the speeds in the various highway sections, with the averages weighted by the lengths of the sections involved.

The delay calculations followed from those of vehicle speeds. Total travel times were calculated for each alternative by multiplying average speeds for the highway sections by the average demand, and adding together the results for the sections. These results were then normalized to base case volumes in order to allow comparability. Delay reductions were then the differences between total normalized travel times for the alternatives, and the total travel time that would prevail for the base or no build case.

---

[1] David Curry and Dudley Anderson, Procedures for Estimating Highway User Cost, Air Pollution, and Noise Effects, NCHRP Report, #133, 1972.

Figure 1: Running Speed, Freeways - Passenger Cars



Source: NCHRP # 133, Figure A-1

C. Travel Time Value and Savings

Travel time is one of the most important technical inputs for determining the extent, nature, and structure of transportation facilities. It is often the basis for selecting a particular routing of traffic, and is used in many trip allocation studies as a part of forecasting facility use.

For many years it has been the practice in highway economy studies to price travel time in dollars. In most instances, the value of time has been determined either through inferring traveler values by analyzing their choices of modes or routes, or through studying wage rates. In this analysis both approaches have been used. For auto drivers, auto passengers, and bus passengers, time values were derived by using results from route and mode choice studies that were conducted in situations analogous to that of the Central Artery. A value of time for these classes of travelers was established at $4.30 per hour. For buses, commercial vehicles, and their drivers,

information on non-distance related costs (e.g., insurance and depreciation) and on driver's wage rates was used. Time savings for both buses and commercial vehicles were valued at $10.00 per hour.

The actual determination of travel time value for auto occupants and bus passengers was based on methods and results from two studies, one by Thomas[2], and the other by Lisco[3]. These studies were conducted under highly selected conditions that were related in several ways to those in the Central Area. First, the values derived applied solely to urban peak-period commuting. Second, the values related only to persons on their home-to-work or work-to-home journeys. Also, they applied to middle to upper-middle class suburbanites. The values of the two studies were developed in 1966 and 1967, respectively.

Thomas offers the only important route choice contribution in the area of revealed commuter behavior. His research, based on driver behavior in eight cities, recommended a commuting time value of $2.80 per hour. Lisco, whose analysis was conducted in the Chicago area, used a mathematical model similar to that used in the Thomas study. His data, however, came from a sample of commuters who faced a trade-off situation between automobiles and public transit. The Lisco study arrived at a time value of $2.50 per hour.

Although the results of either of these two studies could have been adjusted, updated and applied to the Central Artery situation with little difference in the overall outcome, the Lisco results were actually used. This was partly because the Lisco study involved both auto and transit users, and partly because it allowed simple adjustments for use in the Boston area. In order to apply the Chicago results to Boston, two corrections were necessary. These were to reflect the fact that time value correlates closely with income, and to account for inflationary changes. The first correction was an adjustment to make

---

[2]T.C. Thomas, The Value of Time for Passenger Cars, An Experimental Study of Commuters' Values, Vol. II of a report prepared by Stanford Research Institute for the U.S. Bureau of Public Roads, May, 1967.

[3]Thomas Lisco, The Value of Commuters' Travel Time - A Study in Urban Transportation, doctoral dissertation, University of Chicago, June, 1967.

Chicago time values in 1967 comparable to those in Boston at that time. To do this, the Chicago value of $2.50 per hour was lowered to $2.45 for Boston to account for the approximate 2% difference in median incomes between Illinois and Massachusetts that prevailed in 1967. The second correction was to adjust for inflationary and real income changes in Massachusetts between 1967 and 1975. This involved a simple projection of the 1967 Boston value to 1975 using a ratio of 1975 to 1967 Massachusetts median incomes.[4] This yielded the final time value of $4.30 per hour for auto occupants and bus passengers.

To determine the value of travel time savings for trucks and buses, values developed by Adkins, Ward, and McFarland were utilized.[5] Based on data published by the U.S. Department of Labor, Bureau of Labor Statistics, the authors compared vehicle interest, depreciation, and taxes on an hourly basis to establish the values of vehicle time for commercial vehicles throughout various regions of the U.S. Then they added to these values, driver's wages, welfare, workmen's compensation, and FICA taxes. The total hourly costs for trucks in the New England area in 1965 came to $4.89 per hour, and those for buses to $4.97. Using changes in price indices in recent U.S. Department of Labor statistics,[6] these figures were updated in the Central Area Study, respectively, to $9.90 per hour for trucks and $10.00 per hour for buses. For purposes of measuring Central Area benefits, both figures were assumed to be $10.00 per hour.

To apply the calculated time values, it was necessary to determine the appropriate volumes of passengers and vehicles. To apply the time value savings of auto occupants, information was necessary on auto occupancy. For this purpose, counts were taken by the MDPW during the morning peak period both in the North Area of the Central

---

4 "Money Income and Poverty Status of Families and Persons in the United States: 1975 and 1974 Revisions (Advance Report)," U.S. Department of Commerce, Bureau of the Census - Series P-60, #103, issued Sept., 1976.

5 W.G. Adkins, W.W. Allen, and W.F. McFarland, Values of Time Savings of Commercial Vehicles, NCHRP Report #33, 1967.

6 Bulletin #1917, U.S. Department of Labor, Bureau of Labor Statistics.

Artery, and at Southampton Street on the Southeast Expressway. The average auto occupancy for the North Area was estimated at 1.40 passengers per vehicle, and at Southampton Street, the estimate was 1.30. Thus, for purposes of calculating travel time benefits for the Central Area, an average peak period auto occupancy of 1.35 was assumed.

Based on bus counts taken as part of the I-93 Express Lane evaluation, and the Central Transportation Planning Staff transit simulation network, total numbers of buses were estimated. The average peak period occupancy rate was assumed to be 40 passengers per bus. The analysis did not assume any sort of preferential lane for buses in the South or Central Areas.

Finally, it was necessary to determine the total number of trucks. This figure was taken from the same sources used in the traffic estimation procedure. Trucks were estimated at 3.5% of total traffic volumes.

In estimating the values of total time savings associated with the various alternatives, a conservative approach was used. Benefits were calculated only for the AM and PM two hour peak periods for the 260 weekdays per year, and only for users of the Central Area section of the Central Artery. As in the case of the delay analyses, benefits from implementation of proposed improvements elsewhere in the corridor were included only insofar as they would be experienced in the Central Area. Benefits to travel on local streets were not included.

D. Vehicle Operating Cost Savings

Exclusive of travel time and accident costs, operating costs of a vehicle when on the highway consist of fuel, oil, tires, depreciation, and maintenance. Other costs, such as license fees, insurance, parking fees, tolls, garage rental, and interest charges are not closely related to design of a highway or to traffic conditions, and thus can be omitted from economic analysis of highway options.

A review of the literature revealed three major sources of information on vehicle operating costs

in the U.S.: Winfrey,[7] Claffey,[8] and Curry and Anderson[9]. Since Curry and Anderson utilized the work of Winfrey and Claffey, and also allowed straight-forward application, the Curry and Anderson work was used to develop Central Area operating costs.

The actual procedure for calculating operating costs had two parts and was done separately for automobiles and trucks. In the first part of the analysis, base case operating costs were developed. These assumed the present level of service"F" prevailing on the Central Section of the Central Artery during peak periods, and included an inflation factor to cover cost increases from 1970, the year of the Curry and Anderson cost indices, to 1975. In the second part of the analysis, operating costs for the various alternatives were related to operating speeds, again with the given inflation factor. The following sections describe the specific procedures used, respectively, for automobiles and trucks.

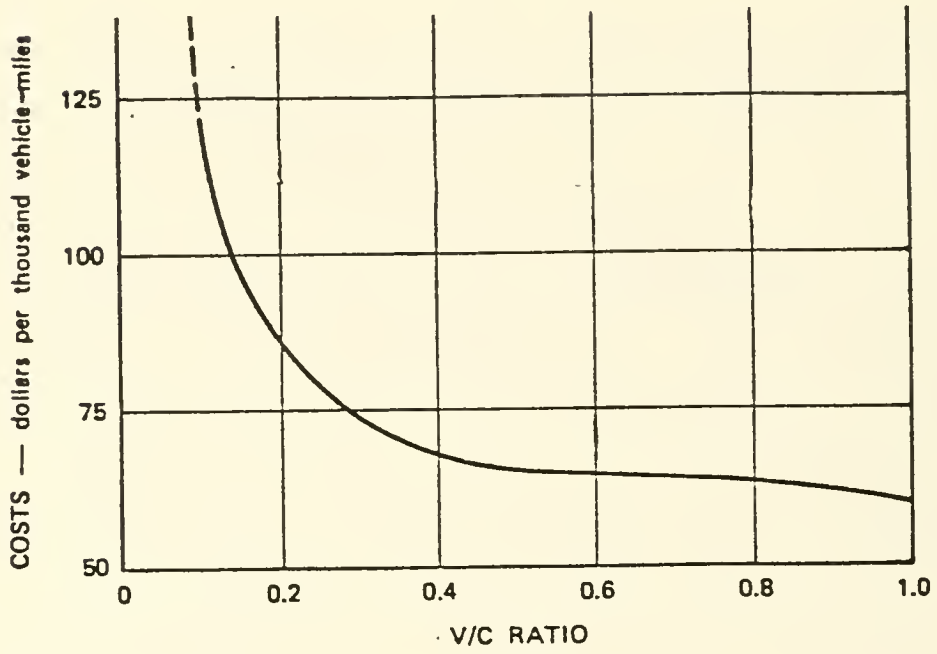
1. Automobile Operating Costs

Base case operating costs for automobiles came directly from Curry and Anderson. Figure 2 shows automobile operating costs as a function of Volume/Capacity (V/C) ratio for level of service "F". As can be seen, costs per 1,000 vehicle miles drop rapidly until a V/C ratio of about .4, and then remain relatively stable after that. Assuming a V/C ratio of .8, (which probably yields a conservative estimate of automobile costs on the Artery), this would imply a base automobile operating cost in 1970 of $62.00 per 1,000 vehicle miles.

To provide an appropriate inflation factor from the 1970 Curry and Anderson costs, an analysis was undertaken of the individual cost components of automobile operation. Analysis by the MDPW revealed increases in the costs of individual items ranging from 25% to 91%. These are shown in Figure 3. Based on the various component costs and cost increases, a conservative estimate was made that overall automobile operating costs increased 35%

7 Robley Winfrey, Economic Analysis for Highways, (International Textbook Company, 1969.)
8 Paul Claffey, Running Costs of Motor Vehicles as Affected by Road Design and Traffic, NCHRP Report #111, 1971.
9 Curry and Anderson, loc. cit.

Figure 2: Automobile Operating Cost Versus Volume/Capacity Ratio for Level of Service F



Source: NCHRP # 133, Figure B

Figure 3: Road User Costs for Passenger Vehicles 1970 and 1975

Cost Item	Unit Price or Factor for Passenger Cars		Percent Increase Over 1970
	1970[1]	1975[2]	
Fuel ($/gallon excluding tax)	0.24	0.46	91
Engine Oil ($/quart)	0.72	1.00	39
Tires ($/tire)	30.00	40.00	33
Depreciation (Vehicle base price)	3400.00	4200.00	23
Maintenance			25

Source: [1]NCHRP #133
[2]MDPW staff analysis

between 1970 and 1975. Applying this to the $62.00 per 1,000 vehicle miles cost for 1970, yielded a base case cost of $83.70 for 1975.

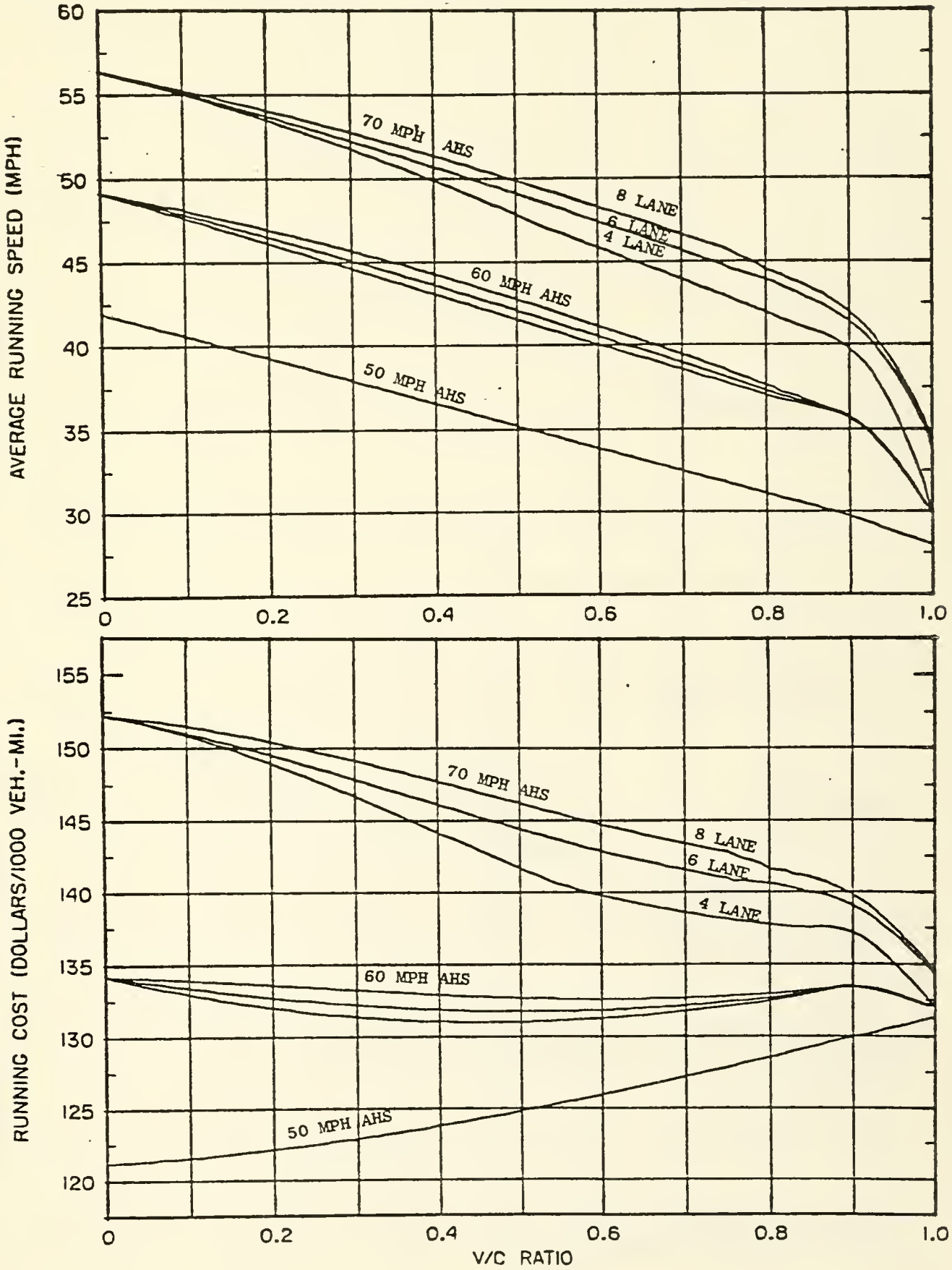
Operating cost estimates for the various Central Area Study Alternatives came from the vehicle speed analysis and from Curry and Anderson. As part of the vehicle speed analysis, highway capacities and volumes were developed for each link of each alternative for peak period travel. The capacities and volumes were applied to Figure 4 (from Curry and Anderson) which relates vehicle speed to Volume/Capacity ratio and Volume/Capacity ratio to operating cost. The 50 MPH Average Highway Speed (design speed) curves were used. Using the individual per mile operating costs derived from Volume/Capacity ratios, total automobile operating costs for each alternative were developed by multiplying the link per vehicle mile costs by the link vehicle miles, and then adding the totals together. After that, the 35% inflation factor was added, and a final 3.5% downward adjustment was made to reflect the fact that only 96.5% of peak period Artery traffic volume is automobiles (3.5% is trucks).

2. Truck Operating Costs

The procedure for developing truck operating costs was analogous to that used for automobiles. Figure 5 shows truck operating costs at level of service "F". Assuming a V/C ratio of 0.8, this gives a 1970 operating cost for trucks of $245.00 per 1,000 vehicle miles. Individual components of truck operating costs are shown in Figure 6. As seen in the figure, truck operating costs rose much more than those for automobiles during the period 1970-1975. The increases ranged from 35% to 525%. Based on the numbers shown in the figure and on the assumption that fuel was a major truck operating cost, it was conservatively estimated that overall truck operating costs rose 67% between 1970 and 1975. This yielded a 1975 base case truck operating cost of $410.50 per 1,000 vehicle miles.

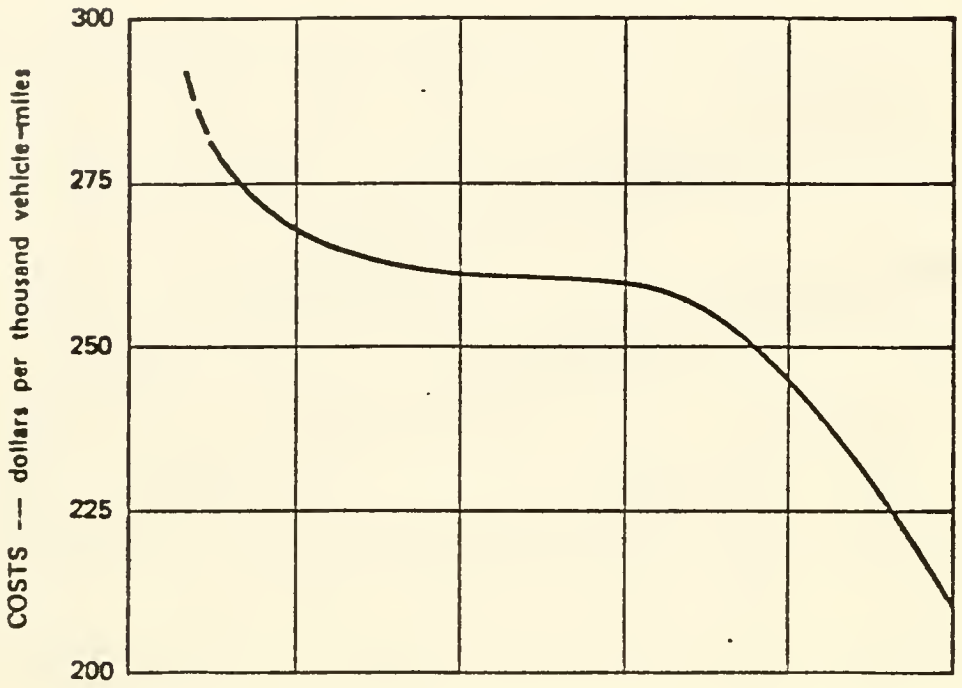
To calculate total truck operating costs for the alternatives, link volumes and speeds were used as before, and applied to the 50 MPH AHS curves of Figure 7, which relates truck vehicle speeds to operating costs. The only difference here between the truck and automobile analyses was that for trucks the 67% inflation factor was used, and that calculations were based on the 3.5% fraction of total traffic volume that trucks represented.

Figure 4: Running Speeds and Costs for Passenger Cars on Freeways



Source: NCHRP #133, Figure A-1

Figure 5: Truck Operating Cost Versus Volume/Capacity Ratio for Level of Service F



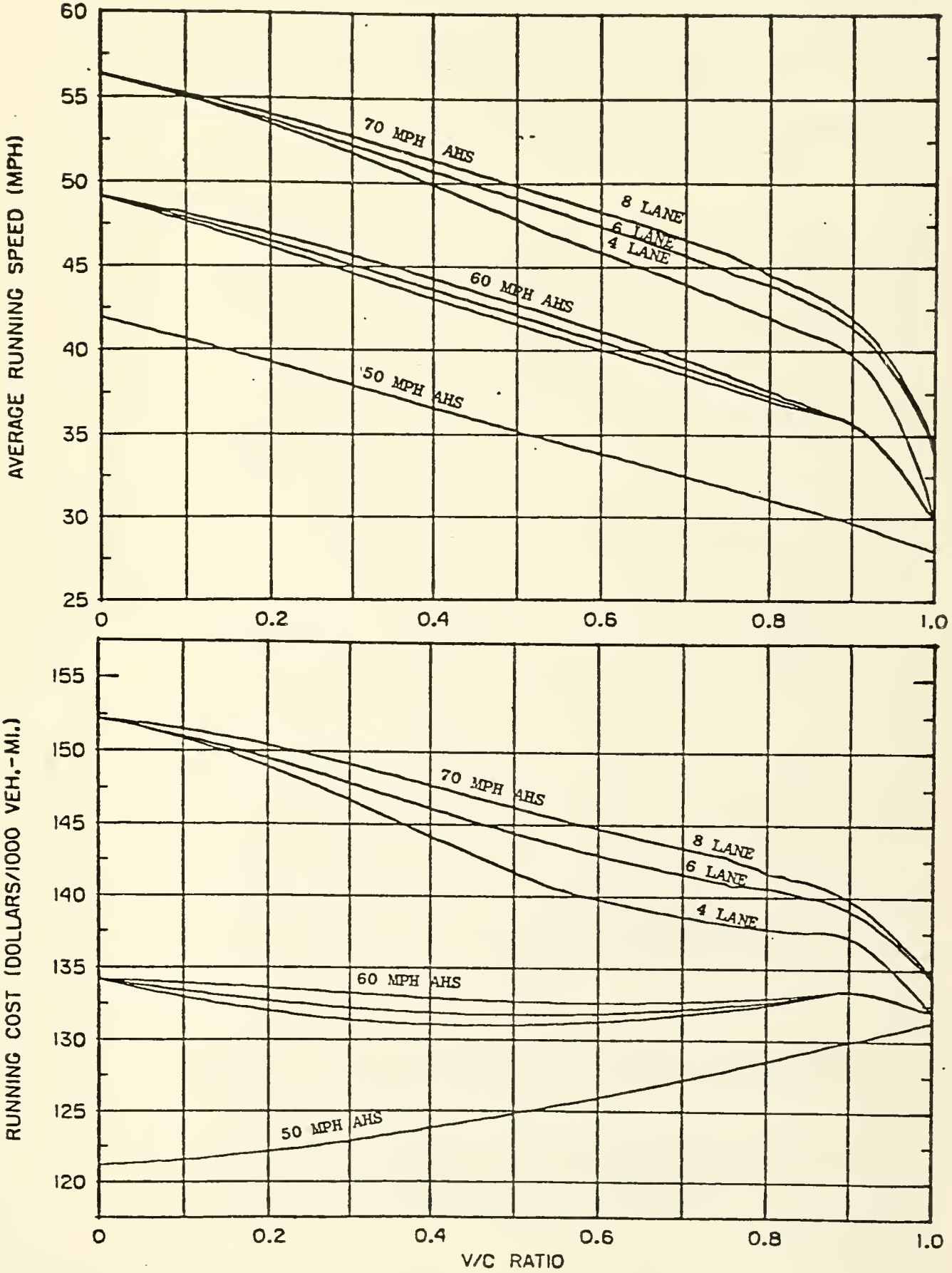
Source: NCHRP #133, Figure 13

Figure 6: Road User Costs for Commercial Vehicles 1970 and 1975

Cost Item	Unit Price or Factor for Trucks		Percent Increase Over 1970
	1970[1]	1975[2]	
Fuel ($/gallon excluding tax)	0.16	0.31	93
Engine Oil ($/quart)	0.20	1.25	525
Depreciation (Vehicle base price)	22,600.00	unknown	--
Maintenance			35

Source: [1]NCHRP # 133
[2]MDPW staff analysis

Figure 7: Running Speeds and Costs for Trucks on Freeways



Source: NCHRP # 133, Figure A-3

To complete the operating cost analysis, the results for trucks and for automobiles were added together for each of the alternatives. Cost savings were the difference in operating costs between the base case (No Build) costs and the calculated costs of the various alternatives.

III. DESIGN STANDARDS AND SAFETY

A. Accidents

A considerable body of research has demonstrated the close relationship between highway design standards and safety. In spite of extensive analysis, however, there still remains insufficient information to accurately estimate future accident experience for many proposed facilities. In particular, while there are good sources of information to use in predicting accident reductions associated with minor spot improvements, research still falls short of making possible highly accurate predictions of accident reductions from major improvements to such complicated areas as the Central Area of the Central Artery. As a result, predictive techniques to forecast probable accident reduction rates associated with Central Area alternatives must be somewhat generalized.

In developing a method for projecting the Artery's future accident experience, it was assumed that the excessive number of accidents on the Central Section of the Artery are primarily caused by the combined total of its design problems. Reflecting this assumption, a method for projecting future accidents was developed which depended on the degree to which the improved Artery would conform with Urban Interstate design standards. Specifically, the method assumed that the accident rate on portions of the improved Artery that met Urban Interstate design standards would drop from that of the present facility to the average rate for Urban Interstate facilities in Massachusetts for 1975 (1.34 accidents per million vehicles miles of travel). Portions not brought into conformance with Urban Interstate standards would have an accident experience the same as that prevailing in the Central Area of the Artery in 1975. The future accident rate calculation was based on the number of miles of future Central Area facility that would conform to Urban Interstate standards as a fraction of total miles of the Central Area facility. Accidents were projected based on vehicle miles and on the normalized link volumes derived from the traffic assignments for the alternatives.

In the accident analysis, accidents by sub-categories were projected based on their relative frequencies in 1975. No attempt was made to project accidents on local streets in the Central Area. It is expected that improved signal systems coupled with proper channelization and more standardized geometrics will significantly improve safety on local streets. Quantification of the safety results of these improvements must wait until the design alternatives are planned.

B. Accident Costs

Associated with accidents are substantial costs, not only for injuries and deaths but also for property damage. As with time savings, it has long been the practice of calculating accident losses in dollar values. Considerable literature has attempted to evaluate the costs of accidents, particularly those involving injuries and fatalities. In this literature, one of the most comprehensive studies was conducted by the National Highway Traffic Safety Administration of the U.S. Department of Transportation in 1972.[10] This study developed societal costs for traffic injuries and deaths for the base year, 1971. The estimated societal costs included both lost wages and additional services required because of accidents. Lost wages were of the persons directly affected; services were for hospital costs, funeral costs, and the like. The NHTSA study established the societal cost of a traffic fatality at $200,000 and that of an average accident injury at $7,300.

A subsequent study by the NHTSA and the Transportation Systems Center of the U.S.D.O.T. updated the 1971 costs to 1974.[11] This was done by multiplying the proportion of total 1971 cost that was due to wage loss, by wage increase factors compounded over three years, and adding this to the proportion of the 1971 cost that was due to service costs, similarly compounded over the three years by service cost increase factors. The resulting total increase factor was then applied to the 1971 costs.

10 Societal Costs of Motor Vehicle Accidents, Preliminary Report, National Highway Traffic Safety Administration, U.S. Dept. of Transportation, 1972.

11 Analysis of Effects of Proposed Changes to Passenger Car Requirements of MYSS208, NHTSA and Transportation Systems Center, U.S. Dept of Transportation, August, 1974.

The specific formulas used for these calculations were as follows:

$$L_{D74} = L_{D71}\left[W_{D71}(1+\Delta W_{71})(1+\Delta W_{72})(1+\Delta W_{73}) + S_{D71}(1+\Delta S_{71})(1+\Delta S_{72})(1+\Delta S_{73})\right]$$

and

$$L_{I74} = L_{I71}\left[W_{I71}(1+\Delta W_{71})(1+\Delta W_{72})(1+\Delta W_{73}) + S_{I71}(1+\Delta S_{71})(1+\Delta S_{72})(1+\Delta S_{73})\right]$$

where

L_{D74} Societal cost of a death in 1974.

L_{D71} Societal cost of a death in 1971.

W_{D71} Fraction of total cost of a death in 1971 due to lost wages.

ΔW_{7i} Wage increase factor for given year in terms of rate of wage increases experienced during that year.

S_{D71} Fraction of total societal cost of a death in 1971 due to service costs.

ΔS_{7i} Service cost increase factor for given year in terms of rate of service cost increases experienced during that year.

L_{I74} Societal cost of an average injury in 1974.

L_{I71} Societal cost of an average injury in 1971.

W_{I71} Fraction of total societal cost of an injury in 1971 due to lost wages.

S_{I71} Fraction of total societal cost of an injury in 1971 due to costs of services.

Using these formulae, the 1974 study calculated the updated cost of a traffic fatality at $242,000 and the cost of an injury at $8,500.

To further update the NHTSA results to 1975 for use in the Central Area analysis, an analogous procedure to that described above was used. The respective wage cost proportions of total costs for the 1974 base were .677 for traffic fatalities, and .178 for injuries. Correspondingly, the service cost proportions were .323 and .822 for fatalities and injuries, respectively. A wage

cost increase of .08 was used for increases in wages during 1974, and a service cost increase factor of .05 was used for increases in the costs of services. From this second updating, the total cost of a traffic death in 1975 was estimated at $259,000, and that of a traffic injury at $9,000.

With societal costs of traffic injuries and fatalities established, it was necessary only to determine average property damage costs for accidents. These were estimated at $550 per accident based on a $500 figure developed by the National Safety Council for 1974, escalated by 10% to 1975.

To calculate accident cost savings for the Central Area alternatives, the accident fatality, injury, and property damage costs discussed above were applied to the accident rates calculated for the alternatives. It was assumed that fatalities and injuries would occur in the same proportions in the alternatives as they did in the Central Area of the Artery during 1975.

IV ENVIRONMENTAL AND COMMUNITY IMPACTS

The Central Area Study text considers five areas of environmental and community quality that might be affected by potential Central Area construction: air quality, noise, water quality, tax base and development, and community quality and character. Two of these, water quality, and community quality and character, are treated fully in the text, and require no further consideration here. The others are taken up below.

A. Air Quality

The air quality section on the Central Area text is intended to provide a basis for Environmental Impact Statement level studies of air quality impact, and to highlight important air quality issues for further consideration. In line with the level of detail contained in the preliminary traffic and other studies, a somewhat simplified calculation of air quality indices was used.

The analysis presented in the air quality section was a determination of gross pollutant emissions, in tons of pollutants per year, generated by traffic only on the Artery under the various alternatives considered. In order to carry out this analysis, total vehicle miles of travel on the Central Section of the Artery and on all ramps were taken from the traffic assignments for the alternatives. Estimated 1975 peak hour volumes

on all links for all alternatives were used to synthesize total annual vehicle miles of travel. Peak hour speed assumptions from the traffic analysis were used for all links, so that reported estimates of CO and HC pollutant burden are conservative. The NO_x totals are probably underestimated, since NO_x emission factors increase as speed increases.

All VMT totals computed were based on 1975 travel. To correspond with this, the emissions factors used to calculate gross emissions were 1975 average emission factors taken from Environmental Protection Agency documentation.[12] These factors were speed-corrected for assumed operating speeds for each link of the Artery Central Section using correction formulae for light duty gasoline powered vehicles at low altitudes.[13] The resulting emissions factors for different speeds are shown in Figure 8.

Figure 8: Speed Corrected Average Emissions Factors

1975 Base CO = 61.10 (Grams per Vehicle Mile)
1975 Base HC = 8.80
1975 Base NO_x = 4.80

AVG. SPEED (M.P.H.)	CO	HC	NO_x
5.0	253.56	24.20	5.52
10.0	136.25	14.34	4.94
12.0	136.25	14.34	4.94
15.0	78.46	10.56	12.58
16.0	74.16	10.13	12.68
20.0	59.93	8.68	13.10
21.7	55.06	8.17	13.28
25.0	47.19	7.33	13.63
27.2	42.89	6.87	13.88
28.0	41.49	6.72	13.97
30.0	38.31	6.37	14.19
30.8	37.15	6.25	14.29
34.1	33.03	5.80	14.67
35.0	32.06	5.70	14.78
38.0	29.23	5.40	15.14
40.0	27.66	5.24	15.38

[12] Compilation of Air Pollution Emission Factors (AP 42), Supplement 5, Environmental Protection Agency, 1975, Table D.7-1.

[13] Ibid., Tables D.1-23 and D.1-24.

B. Noise

In the Central Area analysis, one generalized approach to noise impact evaluation was undertaken. This utilized a series of field observations that were conducted along the Artery route in the Central Area. These observations were to identify noise-sensitive land uses affected by the central section of the Artery, to locate important noise generators other than the Artery itself, and to supplement the information from earlier Central Artery data collection efforts. The primary result from the observations and from the earlier data was that the Artery itself is not the predominant noise generator in the Central Area. The detailed conclusions from the field observations are presented in the Central Area Study text.

In the South Area analysis, a second approach to noise analysis was undertaken. In this approach, a mathematical noise simulation model was applied to the existing situation and one construction alternative. Because the constraints of the Corridor Planning Study context limited the accuracy of this analysis, and because noise from an in-tunnel Central Area facility would not substantially affect Area noise levels, such simulations were not performed for the Central Area Study. When detailed plans for the Central Area are developed, detailed noise analyses for the Central Area will be undertaken.

C. Land Development and Tax Base

In the Central Area Study analysis, land development potential was determined both in terms of land area that would be newly available for development after Central Artery construction, and in terms of the potential net value of that land. Tax base was not calculated directly, but was projected in general terms based on the possibilities for new development.

New land potentially available for development was primarily the area above any newly depressed facility. The value of the new land was the net of the cost of necessary property takings, and the potential value of the areas to be developed.

Three buildings and certain parking areas presently operating under the Artery structure would be involved in potential takings. The buildings are the Stop & Shop Bakery and the Hoffman Building, of which 50% of each would be taken with reconstruction alternatives, and the Anelex Building, which would be 100% taken. Based on MDPW

assessments, these takings would cost a total of $4,950,000. The parking areas under the Central Section of the Artery presently provide parking for about 380 cars. The land on which these spaces are located was assumed to have a taking cost of $1,333,800.

The value of land newly available for development after Artery reconstruction, was based on a schematic land use plan, and on per square foot value estimates made by the Boston Redevelopment Authority and private realtors. These sources indicated that with a land use plan of low rise development having generous portions of open space, the land to be developed would be worth $15-$30 per square foot, depending on the particular type and intensity of development. In performing the land value projection calculation, both the $15 and the $30 figures were used, giving a high and a low estimate. In the projection it was assumed that non-developed land would retain its development value, even if it were left as open space. Such land in the schematic plan was valued at the $30 per square foot figure.

In the analysis of land value and tax base, one important potential impact was neglected. This was the general increase in property values that would take place in the Artery Corridor once the negative impacts of the Artery were removed.

V. CONSTRUCTION COSTS AND IMPACTS

Construction costs for the Central Area alternatives were developed by the MDPW to be in accord with the 1977 Interstate Cost Estimate. As such, they were based on cost indices that prevailed during 1975.

In the cost estimation procedure, costs were first estimated for typical sections of construction involved, e.g., tunnel, viaduct, ramps; and for normal accompanying structures such as signing, lighting, and ventilation. Quantities of materials were usually calculated on a lineal foot or unit basis. Costs for individual items of work were generally developed from bid costs for construction within the Boston metropolitan area.

In applying the standard cost indices to the alternatives, estimates were made of the lineal feet or the numbers of units of the various types of construction in each alternative. These estimates were then applied directly to the per lineal foot and unit costs calculated earlier.

In all cost estimation, demolition costs were

included as appropriate. It was assumed that the materials in demolished structures would have a zero net value.

Two types of construction impacts were considered in the Central Area analysis: construction duration and traffic disruption. Construction duration was estimated based on the experience of the MDPW in earlier highway construction projects. Potential traffic disruption associated with the alternatives was broadly estimated based on staging requirements and the nature of construction.

BIBLIOGRAPHY

Adkins, W.G.; Allen, W.W.; McFarland, W.F.: "Values of Time Savings of Commercial Vehicles," NCHRP #33, 1967.

Anderson, Dudley G. and Curry, David A.: "Procedures for Estimating Highway User Cost, Air Pollution, and Noise Effects," NCHRP #133, 1972.

Claffey, Paul: "Running Costs of Motor Vehicles as Affected by Road Design and Traffic", NCHRP #111, 1971.

Lisco, T.E.: "The Value of Commuters' Time - A Study in Urban Transportation", Doctoral Dissertation, University of Chicago, 1967.

Thomas, T.C.: "The Value of Time for Passenger Cars: An Experimental Study of Commuters' Values," Volume II of a report prepared by the Stanford Research Institute for the U.S. Bureau of Public Roads, 1967.

U.S. Department of Commerce, Bureau of the Census, "Money Income and Poverty Status of Families and Persons in the United States: 1975 and 1974 Revisions (Advance Report)," Series P-60, #103, 1976.

U.S. Environmental Protection Agency, "Compilation of Air Pollution Emission Factors (AP 42), Supplement 5," 1975.

U.S. Department of Labor, Bureau of Labor Statistics, Bulletin #1917.

U.S. Department of Transportation, National Highway Traffic and Safety Administration and Transportation Systems Center: "Analysis of Effects of Proposed Changes to Passenger Car Requirements of MVSS 208", 1974.

U.S. Department of Transportation, National High way Traffic Safety Administration: "Societal Costs of Motor Vehicle Accidents, Preliminary Report," 1972.

Winfrey, Robley: "Economic Analysis for Highways," International Textbook Company, 1969.

7865 041

BOSTON PUBLIC LIBRARY
3 9999 06315 190 4